Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JANUARY, 1954

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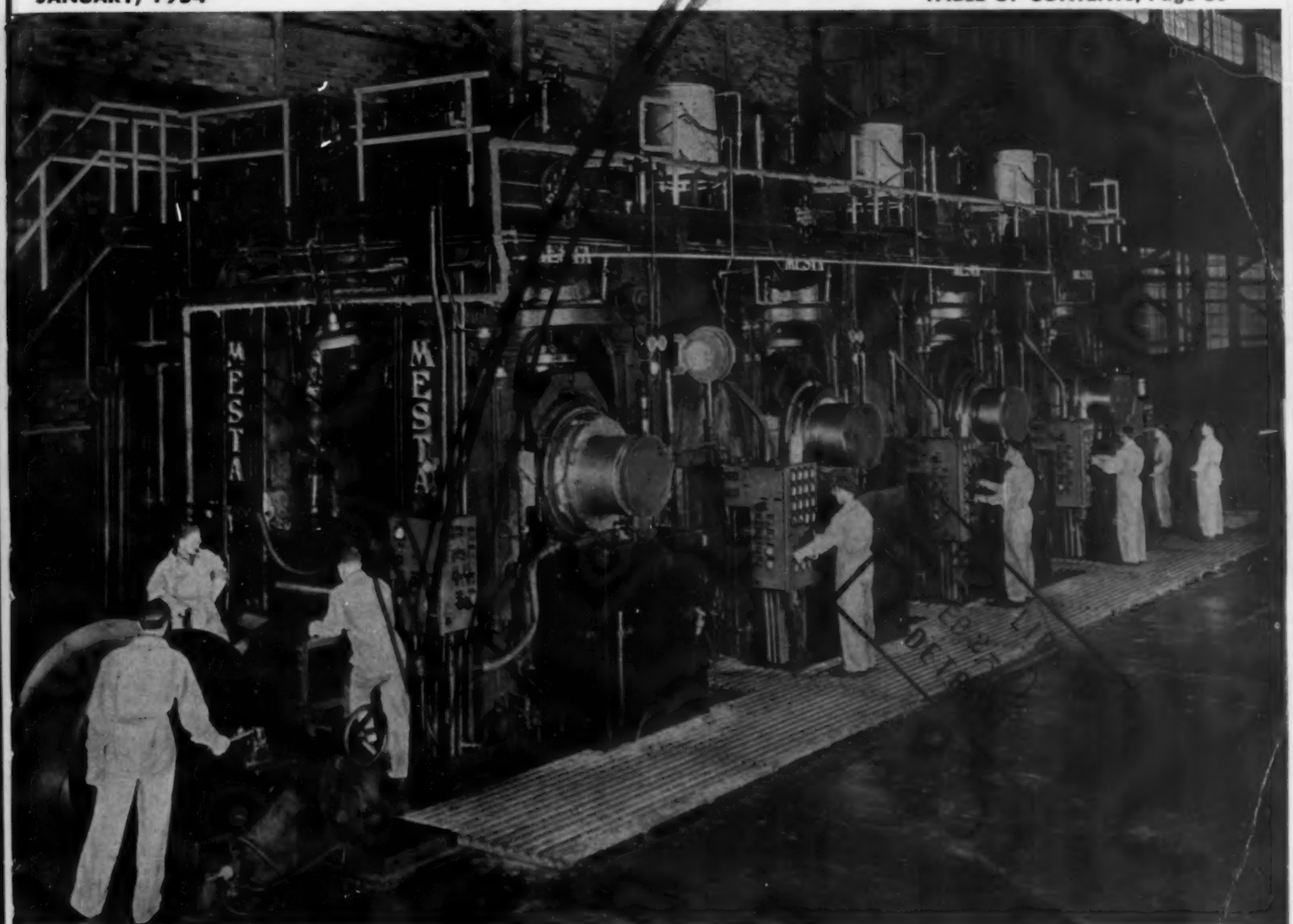


MESTA 56" FOUR-HIGH, FOUR-STAND TANDEM COLD MILL

Designed and Built by MESTA

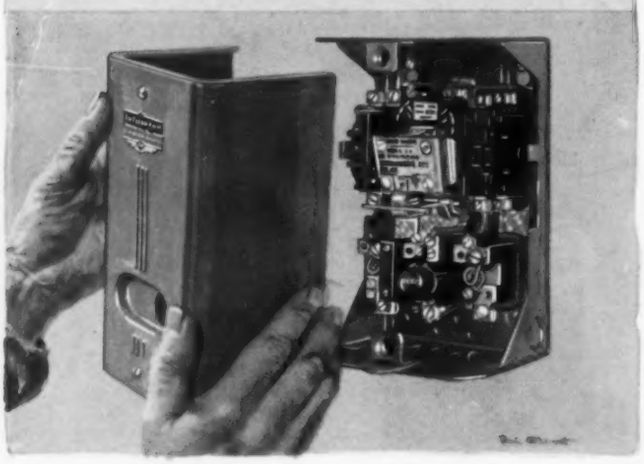
for SOUTH AFRICA IRON & STEEL
INDUSTRIAL CORPORATION, LTD.
PRETORIA, SOUTH AFRICA

Designers and Builders of Complete Steel Plants
MESTA MACHINE COMPANY
PITTSBURGH, PENNSYLVANIA

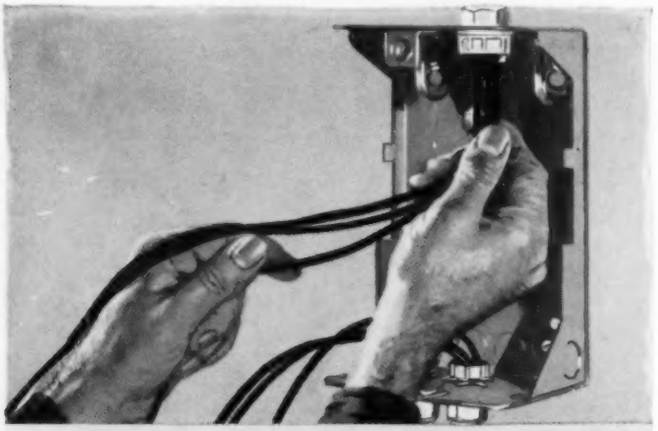
THE THREE CUTLER-HAMMER STARS ★ ★ ★ STAND FOR THREE NEW STANDARDS

☆ installs easier
☆ works better
☆ lasts longer

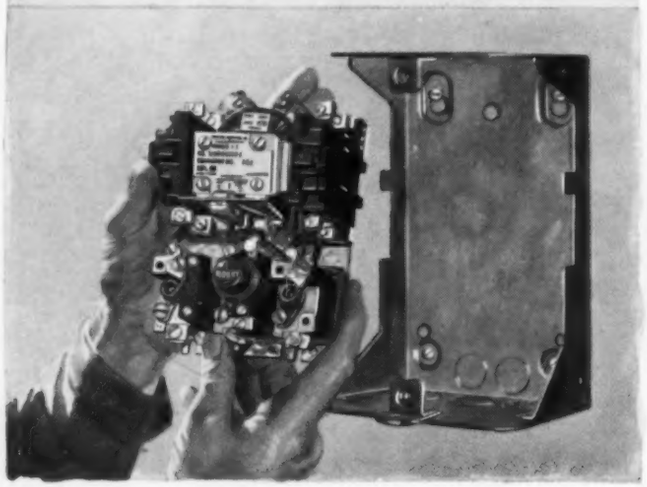
1. Just loosen two screws . . . and off comes wrap-around cover. Screws stay in cover, do not fall into machines or get lost on floor; a typical time-saving design detail.



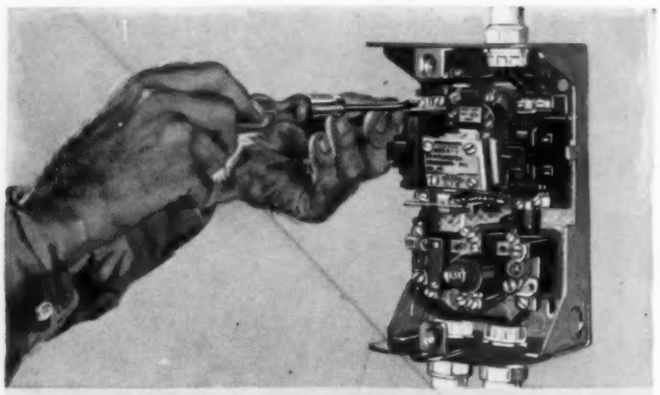
3. Pull in wires . . . Making conduit connections and pulling wires is a cinch. No starter mechanism or side walls of case in the way. No skinned knuckles or damaged starters.



2. Remove entire starter mechanism . . . by merely loosening three screws. Then light, easy-to-handle skeleton case can be installed. Embossed mounts for good job on uneven surfaces. And upper mounting holes are keyhole slotted.



4. Connect up and go . . . Straight-through wiring; all line terminals at top, load terminals at bottom. All terminals are clearly marked and visible from front. Pressure connectors throughout. All panel wiring is color coded.



Factory records everywhere today show the cost of installing motor control is almost always greater than the cost of the equipment, often two to three times as much. That is why Cutler-Hammer engineering made easier installation a key objective in designing the new Cutler-Hammer ☆ ☆ ☆ Motor Control. When you buy motor control, figure its *real* cost, its installed cost. Then you too will insist on Cutler-Hammer! Your nearby Cutler-Hammer Authorized Distributor is ready to serve your needs. Order from him today.
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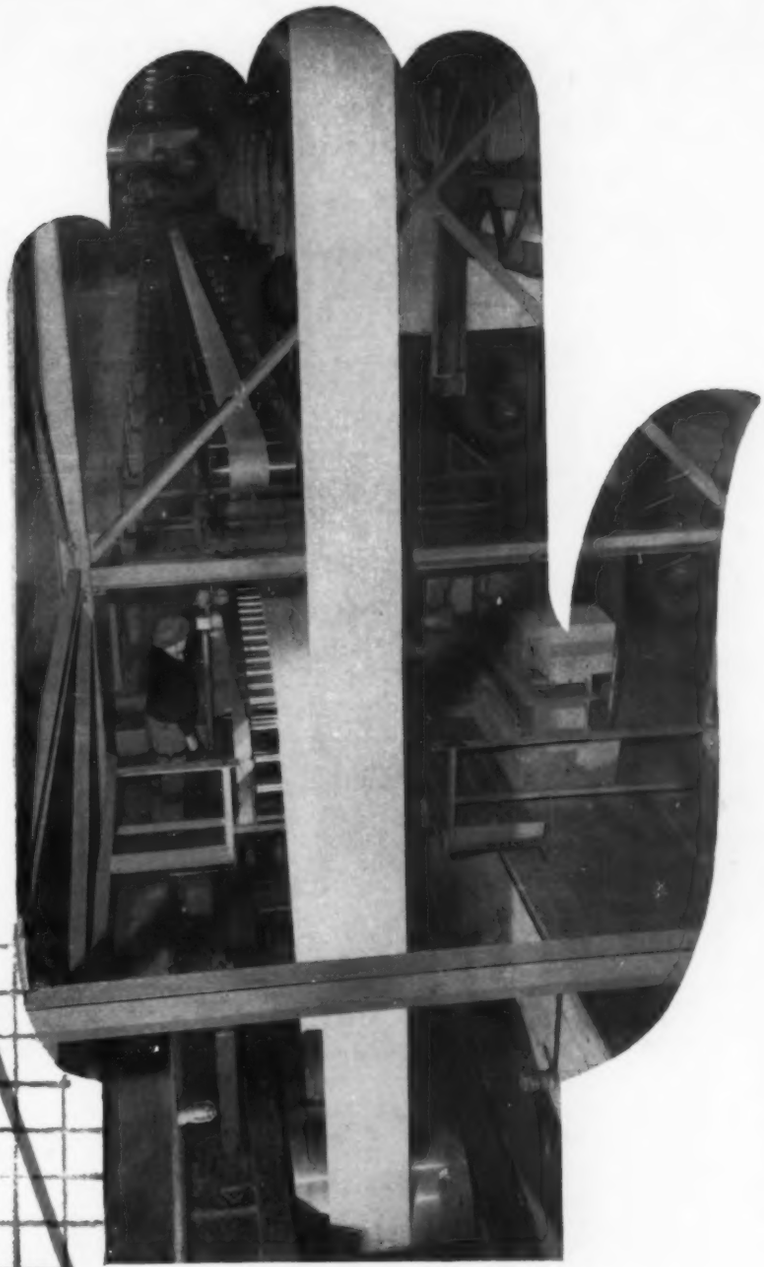
CUTLER-HAMMER ★ ★ ★ MOTOR CONTROL

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 31, No. 1.

R v.31 pt.1 Ja-Je '54

good equipment keeps production costs DOWN



seamless tube mills
continuous butt weld pipe mills
continuous coating lines
flat-rolled finishing equipment
drawbenches

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Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.
Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.
M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.
Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.
Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.
Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.
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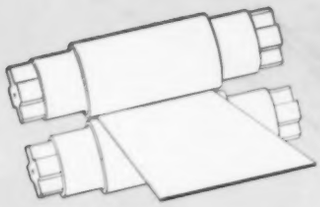
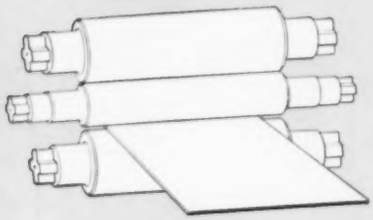
Tech



Roll STRIP, SHEET, PLATE with



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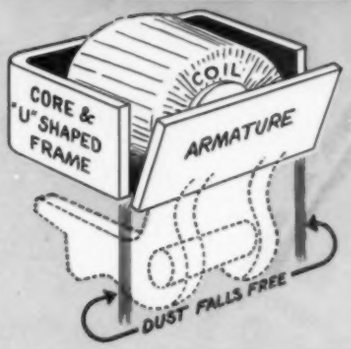
for greater tonnage with less downtime!

THE NATIONAL ROLL & FOUNDRY CO.

Avonmore, Pennsylvania

SPECIALISTS IN IRON, ALLOY IRON AND STEEL ROLLS AND CASTINGS
STEEL ARMOR CASTINGS

IMPROVED
EC&M *LINE-ARC* Contactors
CUT OPERATING COSTS



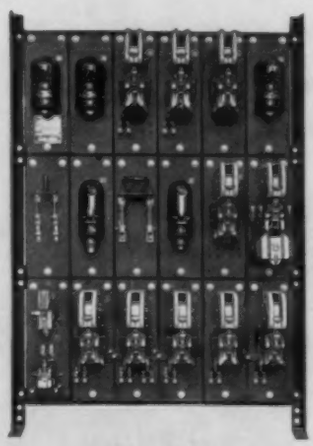
Solves the dust problem—lets magnetic dust fall free.

Contacts remain cool in operation — have long life.

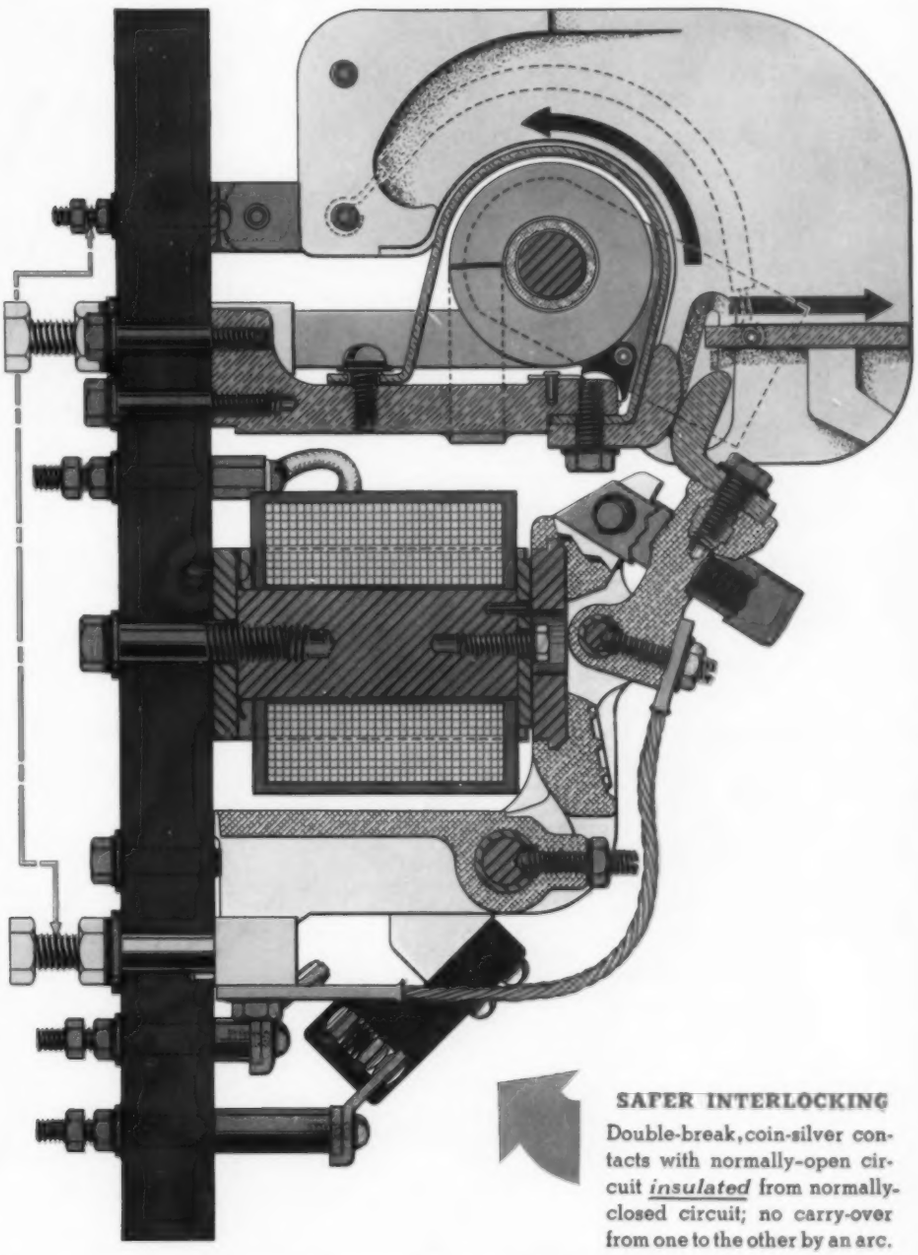
Improved EC&M LINE-ARC Contactors allow the magnetic dust to fall free. They have no mechanical shelf in the magnetic path to catch it. They use safer electrical interlocks.

The well-known EC&M LINE-ARC principle provides high arc-rupturing ability and long contact life through cool contact operation.

EC&M Contactors of LINE-ARC design have a long-standing reputation for efficient operating results. These improved contactors give performance far superior to any previous standard of comparison. When buying crane and mill auxiliary controllers—specify EC&M LINE-ARC Contactors.



CRANE CONTROLLER



SAFER INTERLOCKING

Double-break, coin-silver contacts with normally-open circuit *insulated* from normally-closed circuit; no carry-over from one to the other by an arc.

1759

THE ELECTRIC CONTROLLER & MFG. CO.

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Extra Tonnage every hour... WITH PERMANENTE 165!

Reports from leading steel producers using Permanente 165 ramming mix for open hearth bottoms show that:

Many furnaces are "tripling"... original tap holes are lasting up to 80 heats without repiping ... production records are being broken, with extra tonnage every hour.

Chances are that the proved superiority of a Permanente 165 bottom, based on records of scores of furnaces, can boost *your* open hearth production well above current rates.

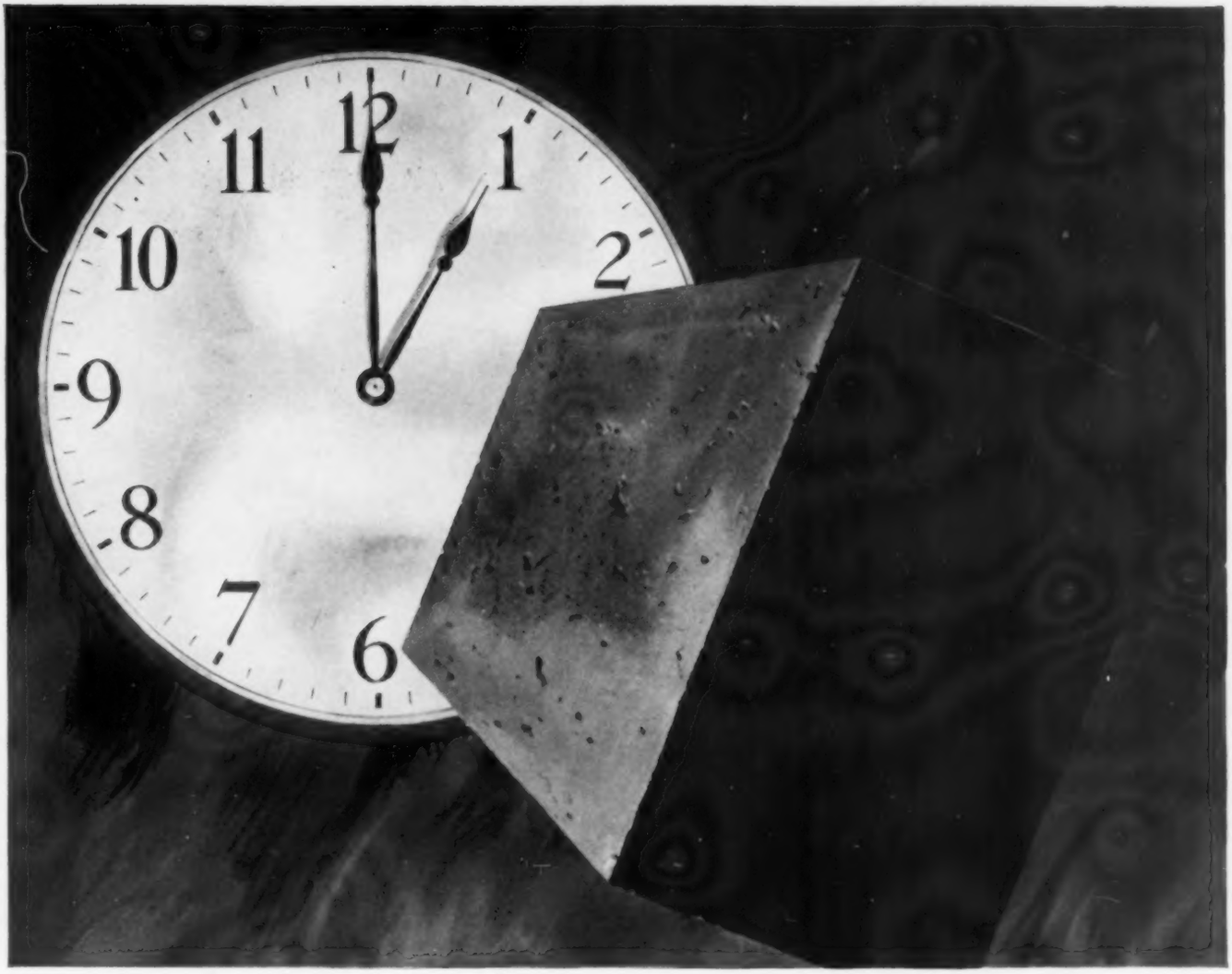
Such performance is possible because patented Permanente 165 is a high MgO *periclase* ramming material derived from sea water magnesia of highest purity.

Pre-shrunk and accurately sized periclase grains assure a bottom of great volume stability—another of Permanente 165's more than *20 quality advantages.*

Your Kaiser refractory engineer will give prompt attention to your refractory problem—will offer, where desired, research, design and installation service to give you maximum production most economically. Write for descriptive literature on (1) Permanente 165, (2) the companion ramming mix, Permanente 84, and (3) Permanente Refractory Brick. Principal sales offices: *Chemical Division*, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. First National Tower, Akron 8, Ohio.

Kaiser Chemicals

Basic Refractory Brick and Ramming Materials



Extra Tonnage every hour WITH PERMANENTE BASIC BRICK!

WHEN you use Permanente *Periclase* basic brick in your steel furnaces you can be sure of longer life in service, less down-time for replacement and repair, extra tonnage every hour.

The outstanding quality of Permanente basic brick has been proved in the furnaces of many of the nation's largest steel producers. Here are a few of its many advantages:

Pre-shrunk, accurately-sized periclase grains derived from sea-water magnesia • Ceramic bond achieved through solid phase reaction • Absence of liquids at operating temperatures • High refractoriness • Maximum density • Resistant to slag attack • High hot load strength • Maximum resistance to abrasion • Superior spall resistance • Excellent volume stability • Clean edges; accurate dimensions

---

PD-B (Periclase "D" burned) brick for open hearth and electric furnace bottoms. Low in iron, lime and silica. Chrome free. Maximum MgO in bottom.

PCA, PCA-MC (Periclase-Chrome "A"), plain and metal-encased for open hearth end walls, front walls and uptakes. Metal-encased for electric furnace sidewalls. High in MgO. Outstanding all-purpose refractory.

CPA-B (Chrome-Periclase "A," burned) for open hearth front and back walls. Controlled chrome additives result in highest resistance to spalling.

CPA-MC (Chrome-Periclase "A"), metal-encased for open hearth back walls, front walls. **D** (Chrome "D" burned) for open hearth bottoms, soaking pits. High hot load strength.

Installation advice on request

Producers of the most complete line of basic refractories

Castables and Mortars • Magnesite • Periclase • Deadburned Dolomite

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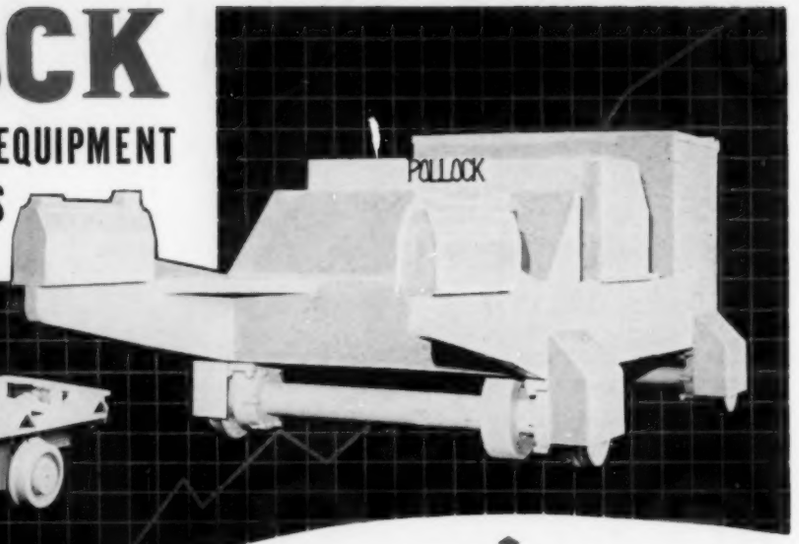
IMPROVED HANDLING EQUIPMENT TO EXPEDITE OPERATIONS



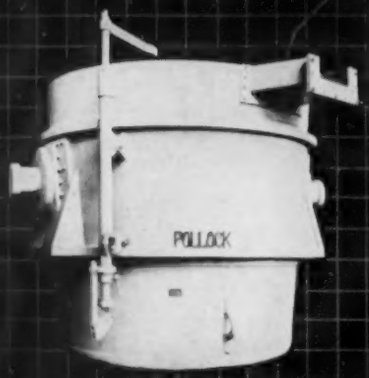
FRONT-FLUSH SLAG CAR

CHARGING BOX CAR

INGOT CAR

an important factor in increased open hearth production

OPEN HEARTH LADLE

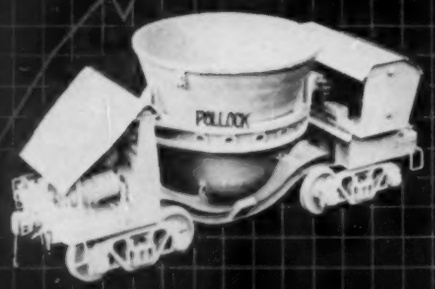


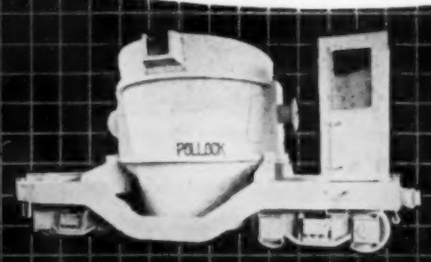
• Pollock experience in the development and construction of open hearth equipment assures smooth flow of operations. To measure use-value of Pollock handling equipment, add their day by day engineering research to 85 years of producing for the steel industry. General specifications available on request. Special-performance details engineered for your needs.

SLAG CAR

DRAG-OUT SLAG CAR

HOT METAL TRANSFER CAR





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YOUNGSTOWN • OHIO
STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS

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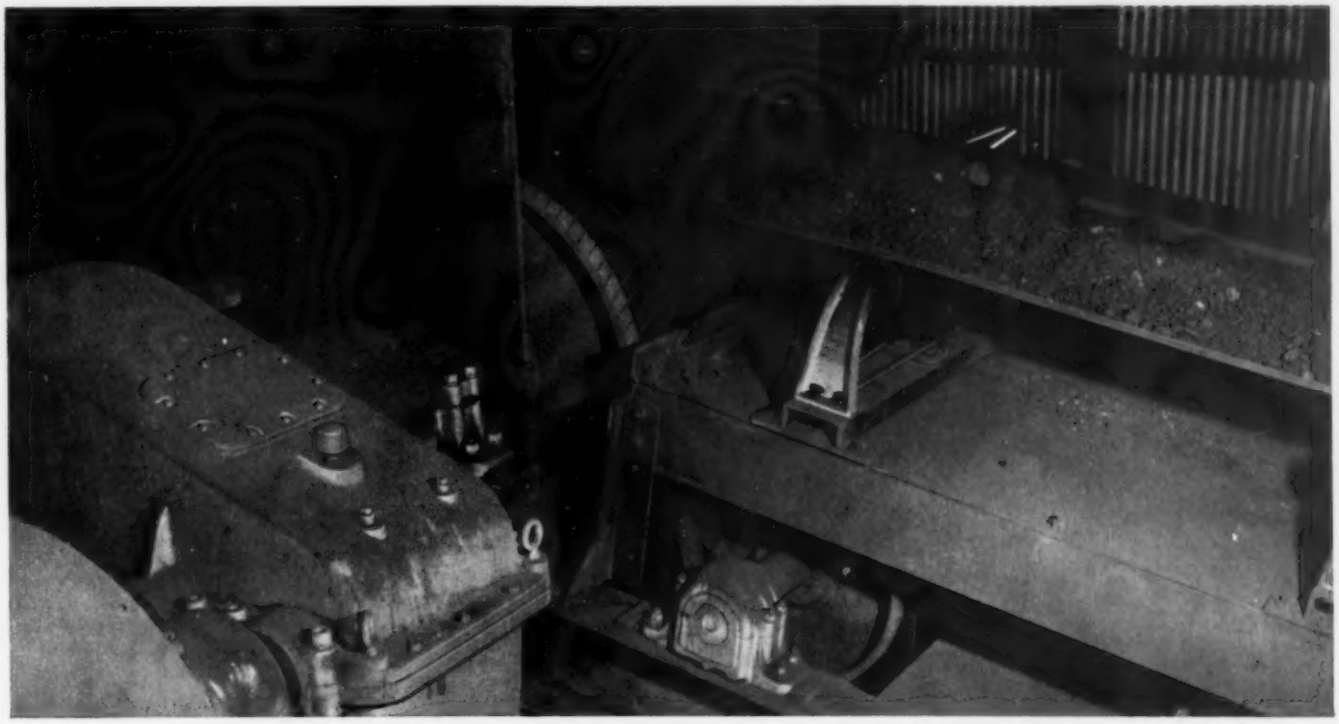
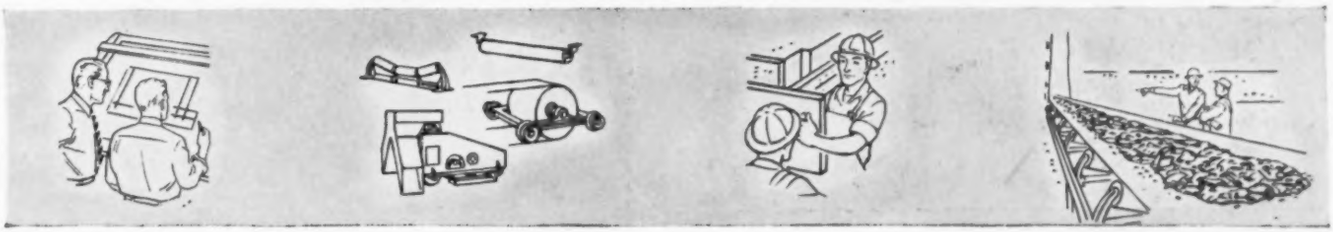
BEAT HIGH TRANSPORTATION COSTS--

carry the load via belt conveyors



Engineered for long-life in ore handling, this Link-Belt 48-inch wide, inclined belt conveyor consists of Series 200 troughing idlers, welded steel pulleys (both plain and rubber lagged), roller bearings and an enclosed gear drive.

LINK-BELT offers you the "total engineering" so necessary for top efficiency



DESIGNED FOR OVERALL EFFICIENCY

Because of its unrivalled experience, Link-Belt can do a better job of gathering and analyzing all data. Proposals reflect this understanding of the most practical way to fit conveyors into your system requirements.

BUILT FOR LONG-LIFE PERFORMANCE

Link-Belt manufactures all components and related feeders and conveyors. You are assured of the right equipment because of this breadth of line. And Link-Belt will supply the highest grade belts engineered to the job.

DELIVERS FULL RATED CAPACITY

Link-Belt follows through on every detail of the job, including electrical controls and even wiring and foundations. What's more, Link-Belt will furnish experienced erection superintendents, staffs and skilled crews.

ASSURES SATISFACTORY PERFORMANCE

When you rely on Link-Belt as a single source for your complete system, Link-Belt accepts responsibility for placing it in full operating readiness. We will also supervise modernization of existing systems.

Next time you're in the market for one belt conveyor or a complete system, call a conveying expert in the Link-Belt office near you. It's his job to help you get the best in belt conveying at the lowest possible overall cost.

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

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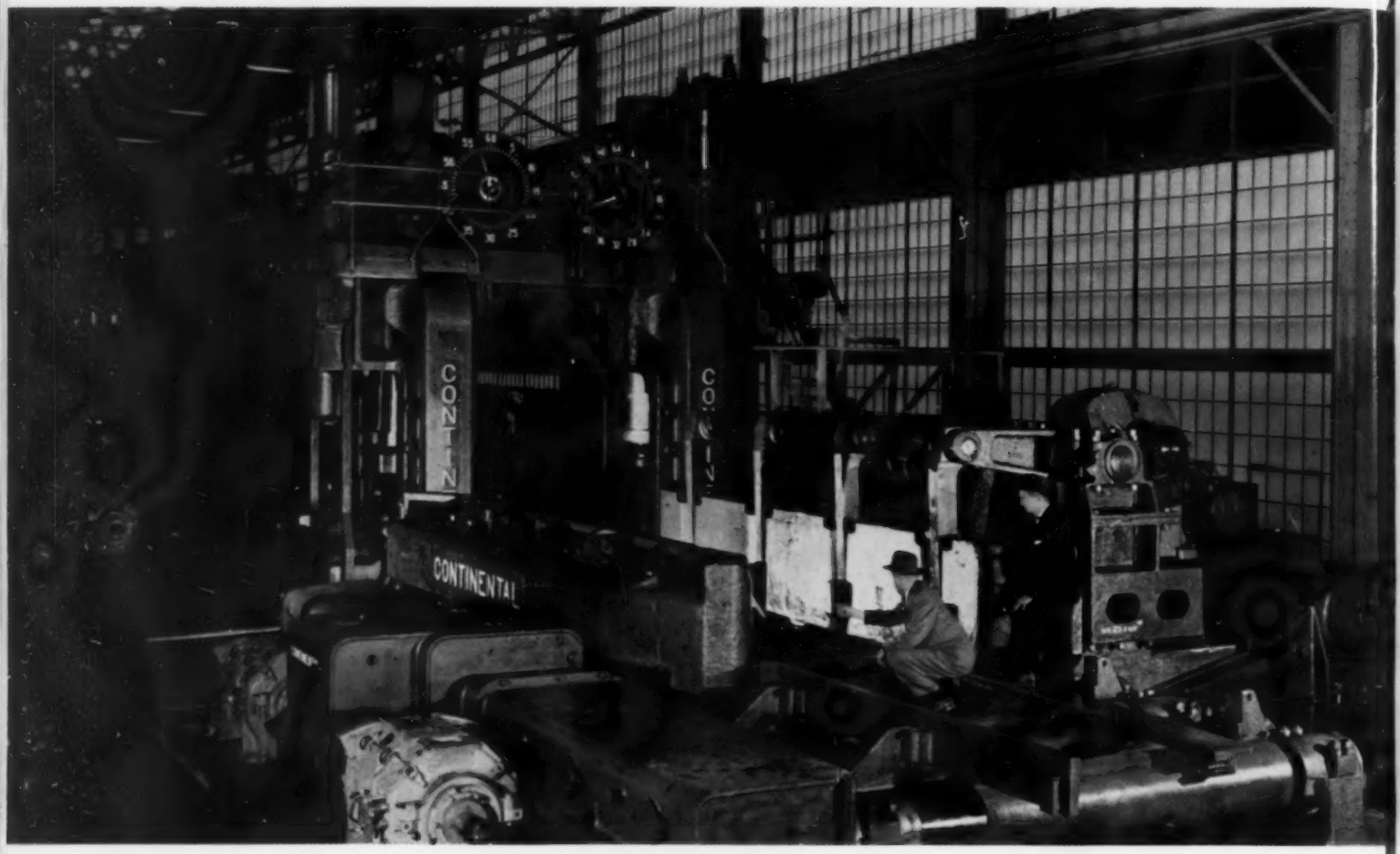
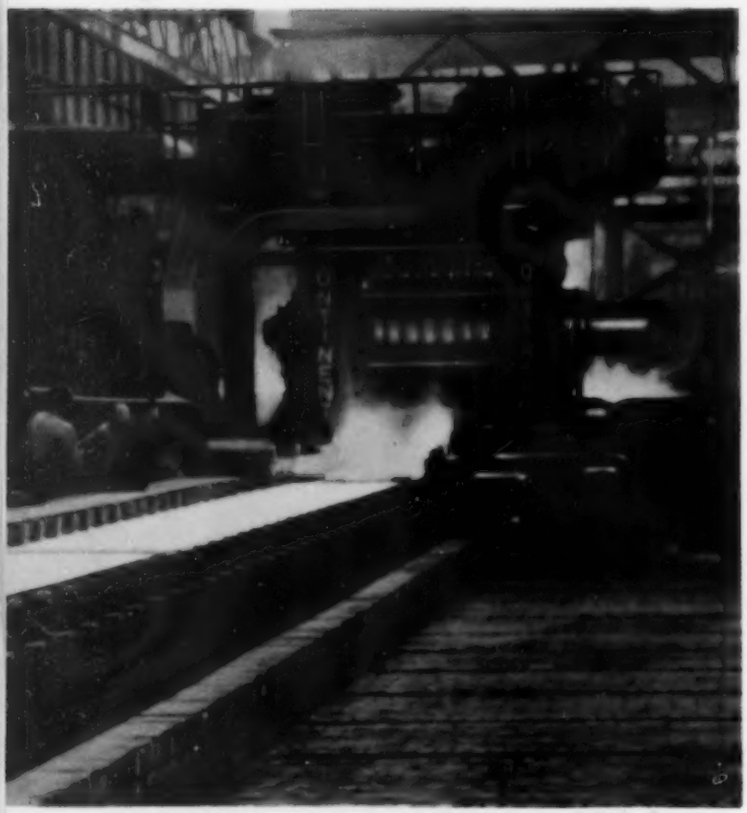
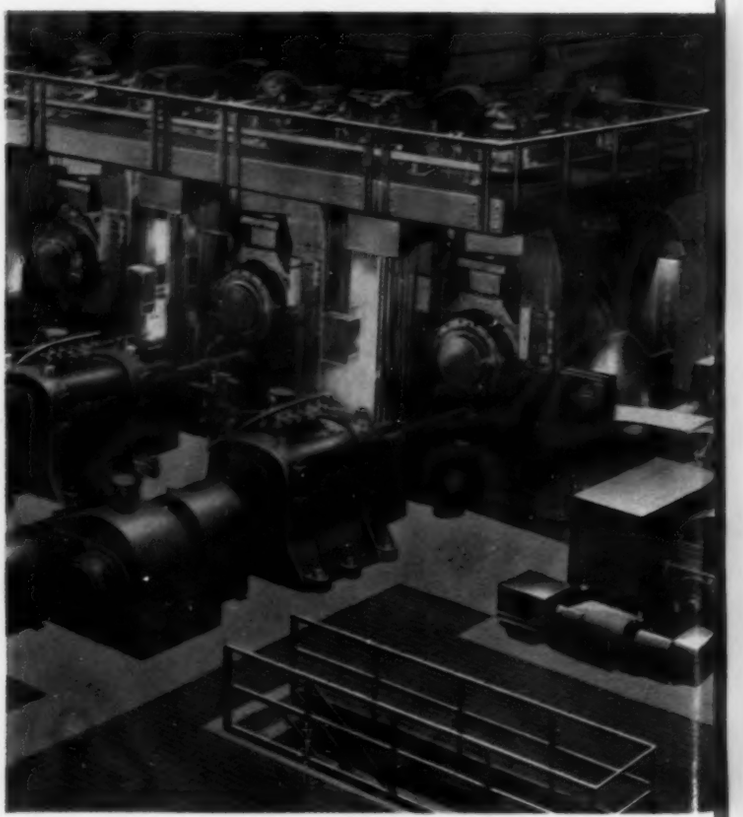
CONTINENTAL



HIGH LIFT BLOOMING-SLABBING MILL



FOUR-HIGH REVERSING HOT MILL



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Rolling Mill installations engineered complete

for steel, alloy and non-ferrous metals

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BILLET MILLS
ROD MILLS
BAR MILLS
MERCHANT MILLS

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SLABBING MILLS
UNIVERSAL MILLS
PLATE MILLS
HOT STRIP MILLS
COLD STRIP MILLS
TEMPER MILLS

Mills complete with Auxiliary Equipment

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ROLL LATHES
CONTINENTAL CHIPPER
SPECIAL MACHINERY

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CASTINGS—carbon and alloy steel from 25 to 300,000 pounds

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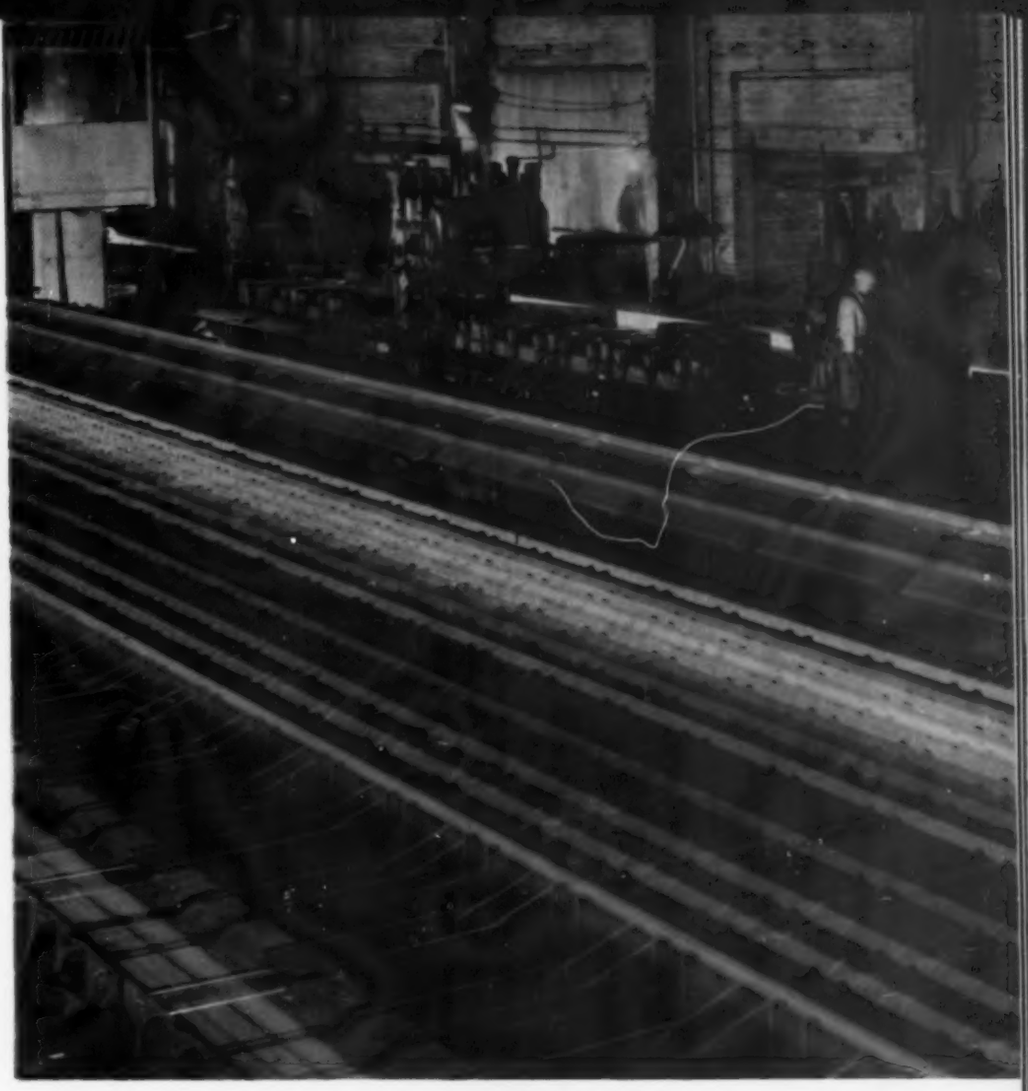

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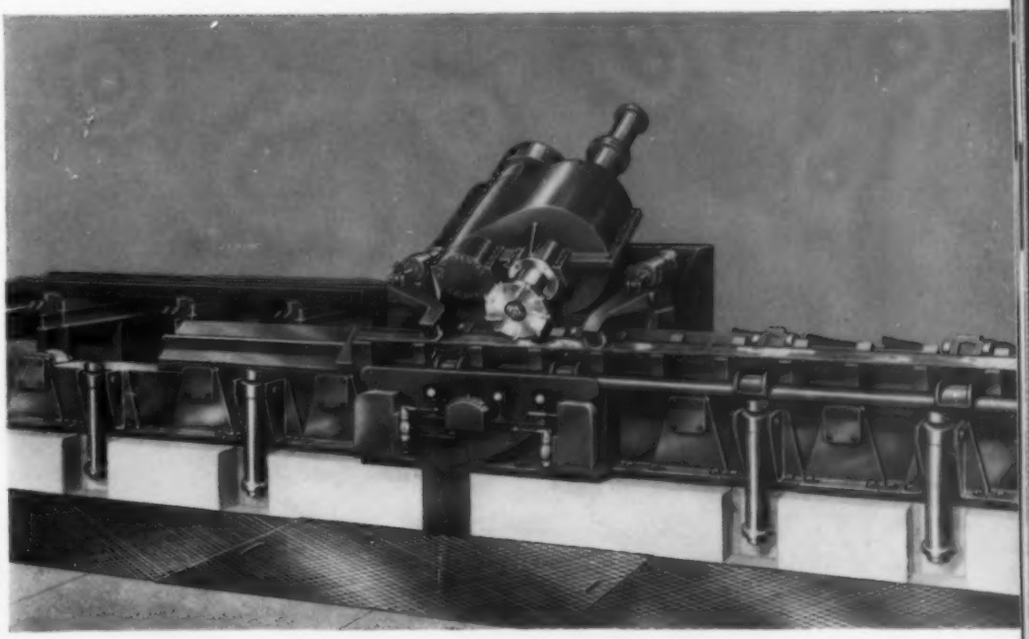
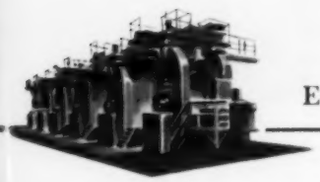
Mechanical surface conditioning for all types of blooms and billets from 1½" to 12" sections; lengths up to 40', in all analyses including carbon, alloy and stainless steel. Operated by one man the Continental Chipper features a direct motor drive with hydraulically adjusted chipping head, planer type bed and hydraulic manipulation of the work at any position. Standard installation includes mechanically operated feed bed and discharge skids. Augmented installations including a billet unscrambler and inspection and marking car available for high production requirements.





Plants at
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CONTINENTAL
Foundry & Machine
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PRODUCTION RESUMED IN 3 DAYS

after $1,000,000 fire at C&D Batteries, Inc.

C & D President, Leon A. Doughty pulls switch to start charging operations.

C & D's block-long plant in Conshohocken, Pa. at the height of the fire, Sunday, November 29.

Despite a $1,000,000 fire that destroyed the main buildings, offices, engineering department, and laboratory of C & D's plant on Sunday, November 29, 1953, production was resumed in three days.

On Tuesday, December 1, space was leased in a nearby plant for setting up new production facilities. On Wednesday, December 2, new batteries that had escaped the fire were being charged on new lines, and grid casting was begun next morning.

The new facilities were in operation on December 10. The salvaged portions of the main plant and the leased facilities were combined to achieve full production by Christmas.

We thank our customers for their patience in bearing with us during delays in shipping, and assure them that the high quality of C & D products is being maintained. *We are deeply grateful to our many friends who have generously given us their kind understanding and support.*

Philadelphia Inquirer Photos

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Two Men Seized in Bakery Holdup

Two holdup men were captured by police late last night, within 15 minutes after they robbed a bakery, on Dryrum ave. near Oster st., of $122.

The robbery occurred in Vern's Bakery, at 9718 Dryrum Aven... mer...

the place at 10:35 P. M. The younger one held his hand in ...is coat pocke... if ...

Auto Strikes Man Carrying Box

A man carrying a bo
93rd st. near Putnam
shor... afte...

C&D BATTERIES, INC.

of Conshohocken, Pa.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES FROM COAST TO COAST

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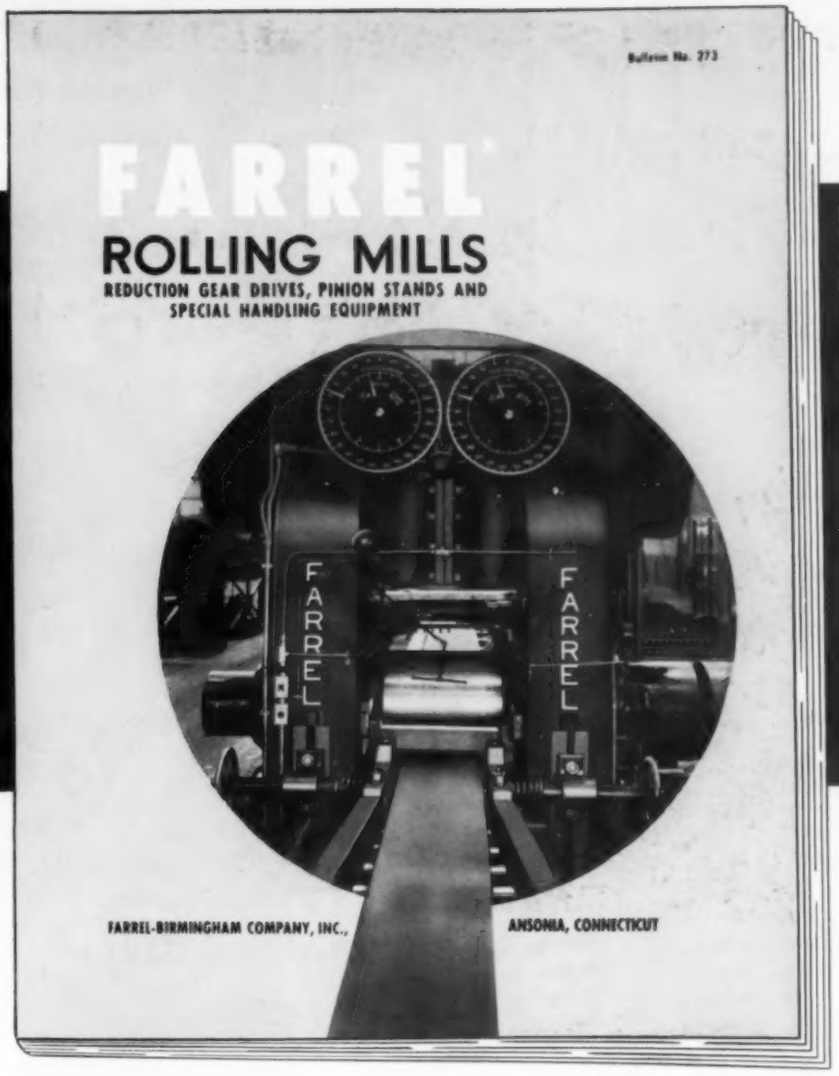

This new 36-page bulletin contains a wealth of information about Farrel rolling mills, gear drives, pinion stands and special handling equipment. For example:

ROLLING MILLS—The first twenty-three pages contain illustrations and brief descriptions of more than thirty sizes and types of mills for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. These range in size from a 30″ x 36″ cold brass breakdown mill to a 6″ x 6″ self-contained unit suitable for laboratory work or specialized production.

REDUCTION GEAR DRIVES AND PINION STANDS—Under this heading you will find four pages of data on single and double reduction gear drives, pinion stands and combination units.

SPECIAL HANDLING EQUIPMENT—Pages 28 to 31 show examples of handling and manipulating equipment specially designed and built to meet individual requirements.

Send for your copy of this new bulletin. Just fill out the coupon and mail it today.

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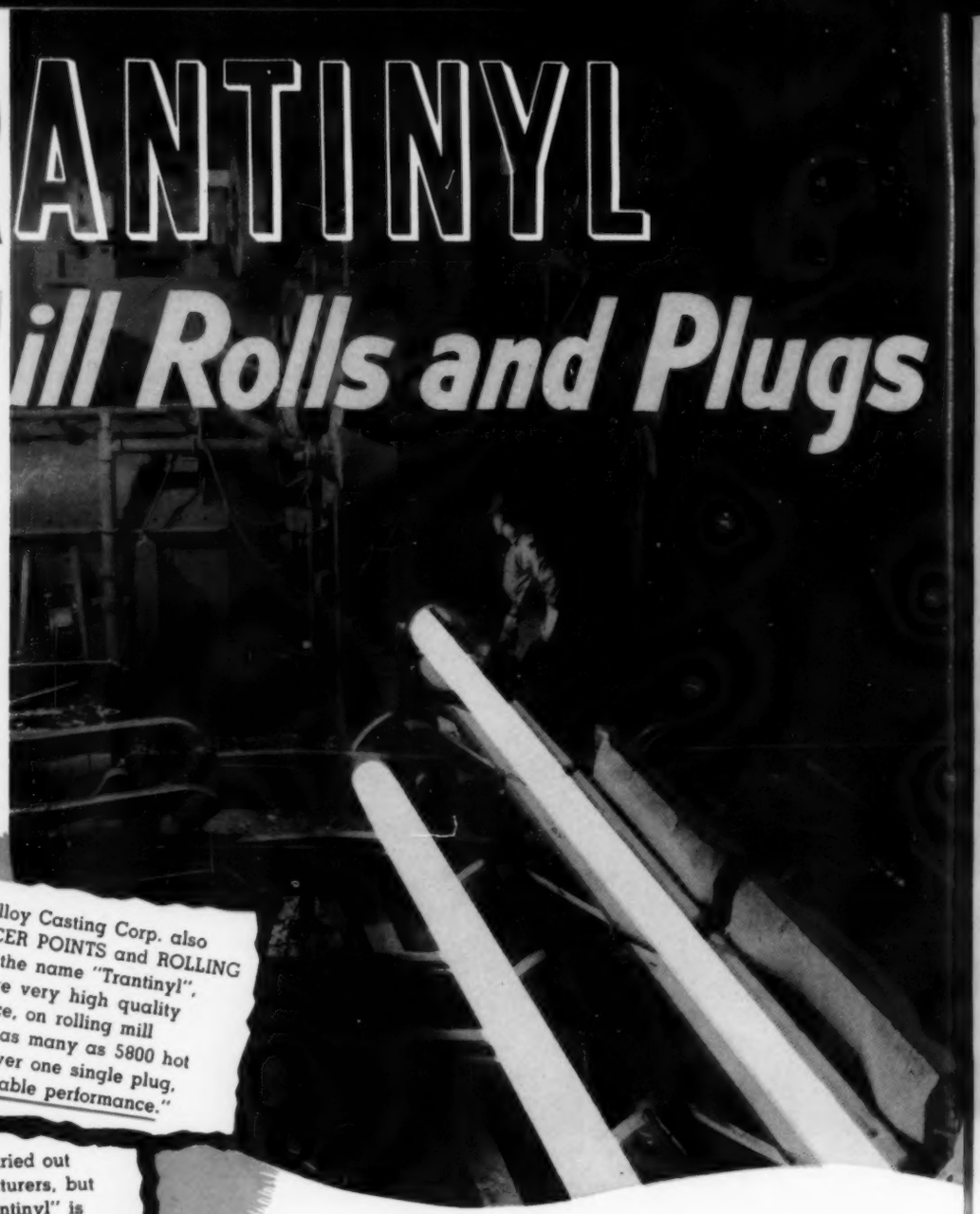
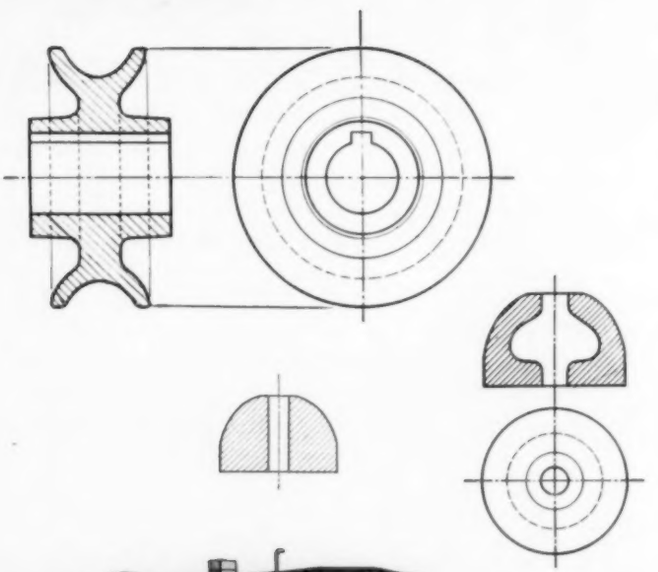
...SAY TUBE MILL MEN



"The Youngstown Alloy Casting Corp. also manufactures PIERCER POINTS and ROLLING MILL PLUGS under the name "Trantinyl", and both of them are very high quality products. For instance, on rolling mill plugs, we have had as many as 5800 hot billet passes rolled over one single plug, which is very remarkable performance."

"From time to time we have tried out samples from other manufacturers, but the performance of the "Trantinyl" is so superior that there is no comparison."

"We feel rather kindly toward Youngstown Alloy Casting Corporation because of the quality of the products they have furnished us, which have contributed much toward our success in overcoming mill delays, and toward our success in manufacturing Seamless Tubing of a very high quality."



"TRANTINYL GUIDES THE STEEL INDUSTRY"

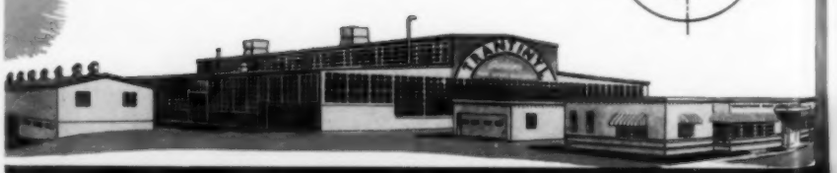
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers

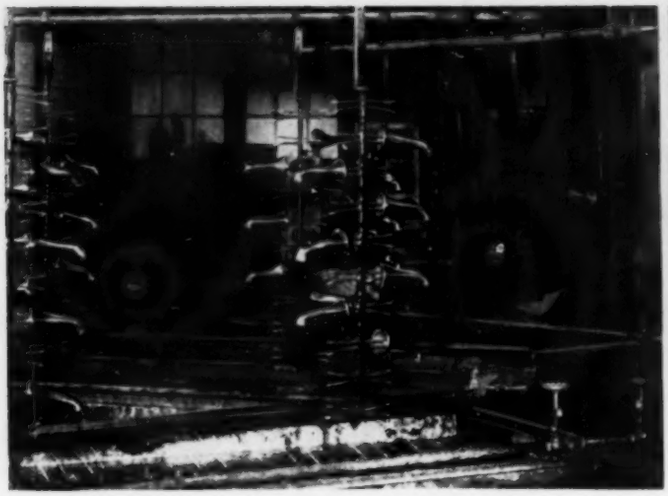
STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE



T-2

Youngstown Alloy Casting Corp.
Youngstown, Ohio



Electromax for plating-tank control at Barnes Manufacturing Co. (plumbing fixtures) saves its cost in 6 months in reduced maintenance. Electromax resists humidity & acid mist.

The Sterling China Co. says "Our two Electromaxes do a perfect job at no expense; no maintenance; no attention from supervisors". Electromax resists dust & vibration.

No-maintenance Controller?

WELL, ALMOST . . .

● For years at a time, your instrument maintenance men may never even see the inside of your Electromax Temperature Controllers.

And when they do look into one, they find only five items that could ever need replacing—two 120-volt light bulbs, two ordinary radio tubes and a relay. All five of these expendable elements could be replaced in five minutes.

Fine engineering, however, greatly reduces the chance of even that much maintenance. Design requires the two radio tubes to operate at only 10% of rating. The relay (the only moving part in the whole instrument) is a hermetically-sealed, plug-in type. There's no dry cell, no standard cell, no ink, no chart, nothing to lubricate.

With its small size, low price, excellent accuracy and really remarkable simplicity, you'll find many uses for Electromax, at temperatures to 1000 F. You can get full information from the L&N office nearest you, or from 4942 Stenton Ave., Philadelphia 44, Pa.

LEEDS NORTHRUP
instruments automatic controls • furnaces

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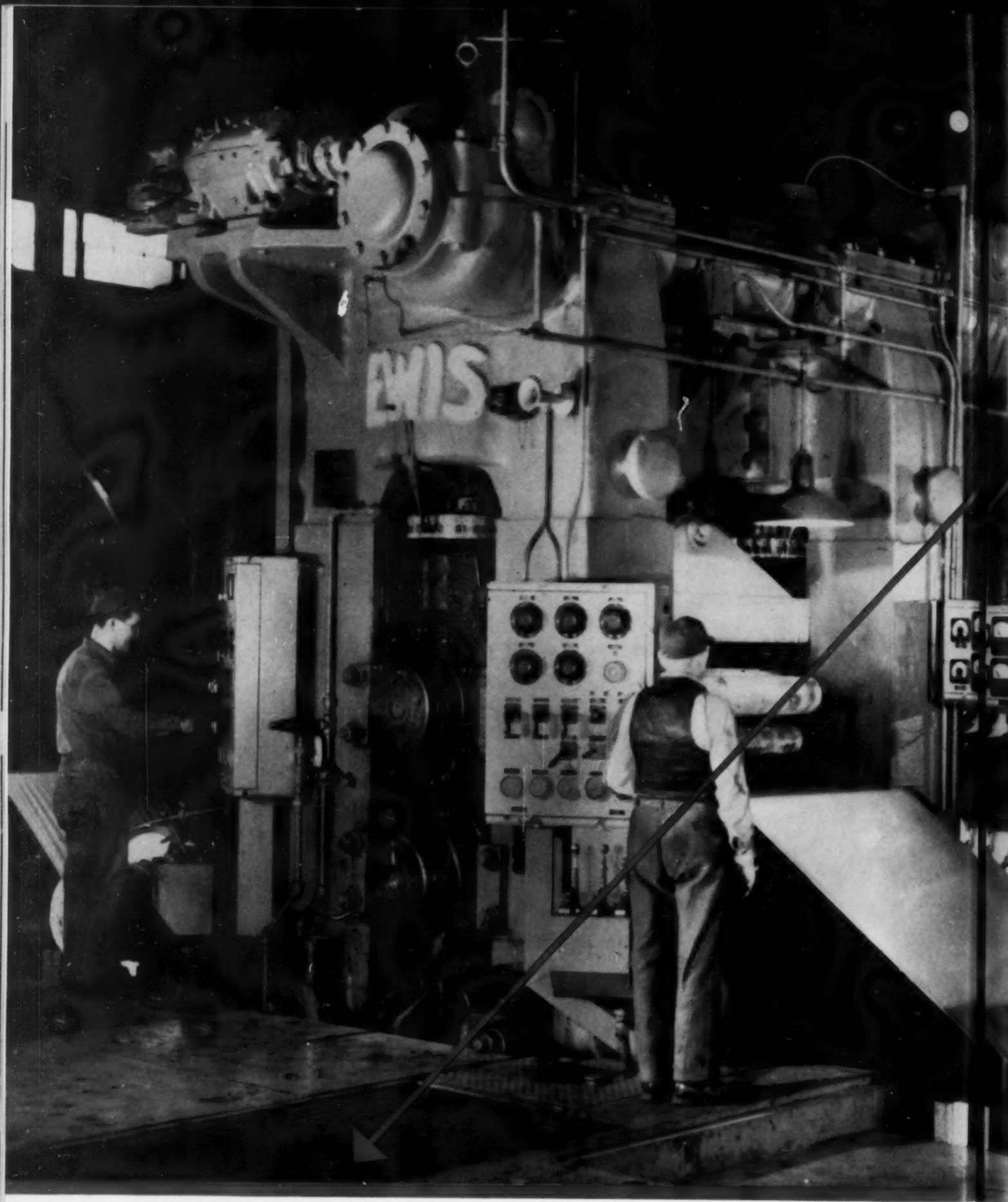


new LEWIS two-high skin pass MILL

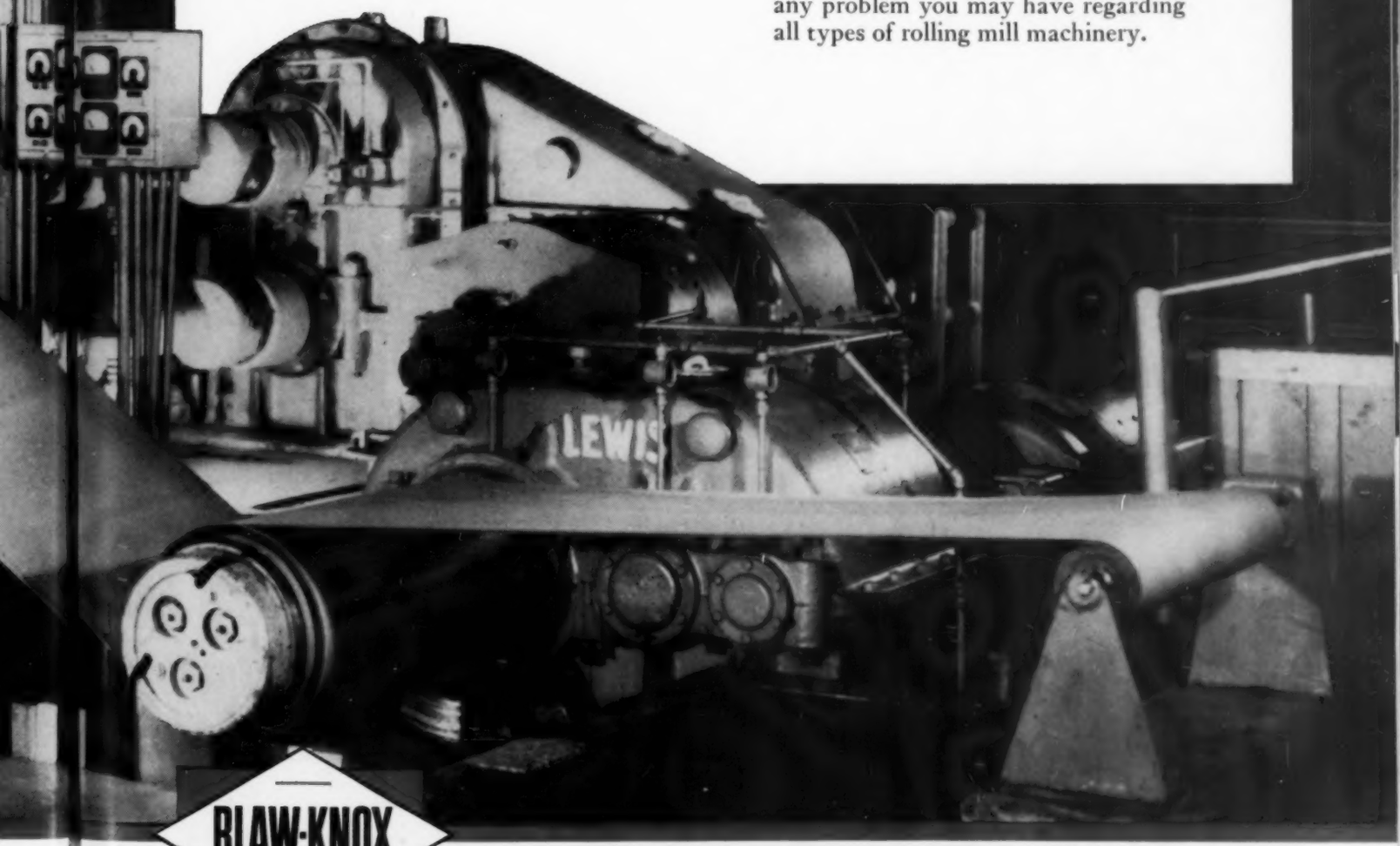
. . . rolls out quality strip of uniform, accurate gauge and high lustre finish

In line with the industry's need for modern, versatile machines to improve quality and increase production, our engineers recently designed and built the Lewis two-high, skin pass Mill.

This new mill operates to very close tolerances, at speeds from 150 to 300 feet per minute on stainless steel. Already built and operating in 28″x42″ and 28″x56″ sizes. Other units, using the same basic design, can be built in sizes to handle the full range of widths and gauges—to meet your particular requirements.

At any time, we will be pleased to give you more complete information about the design and performance of this new Lewis two-high, skin pass Mill.

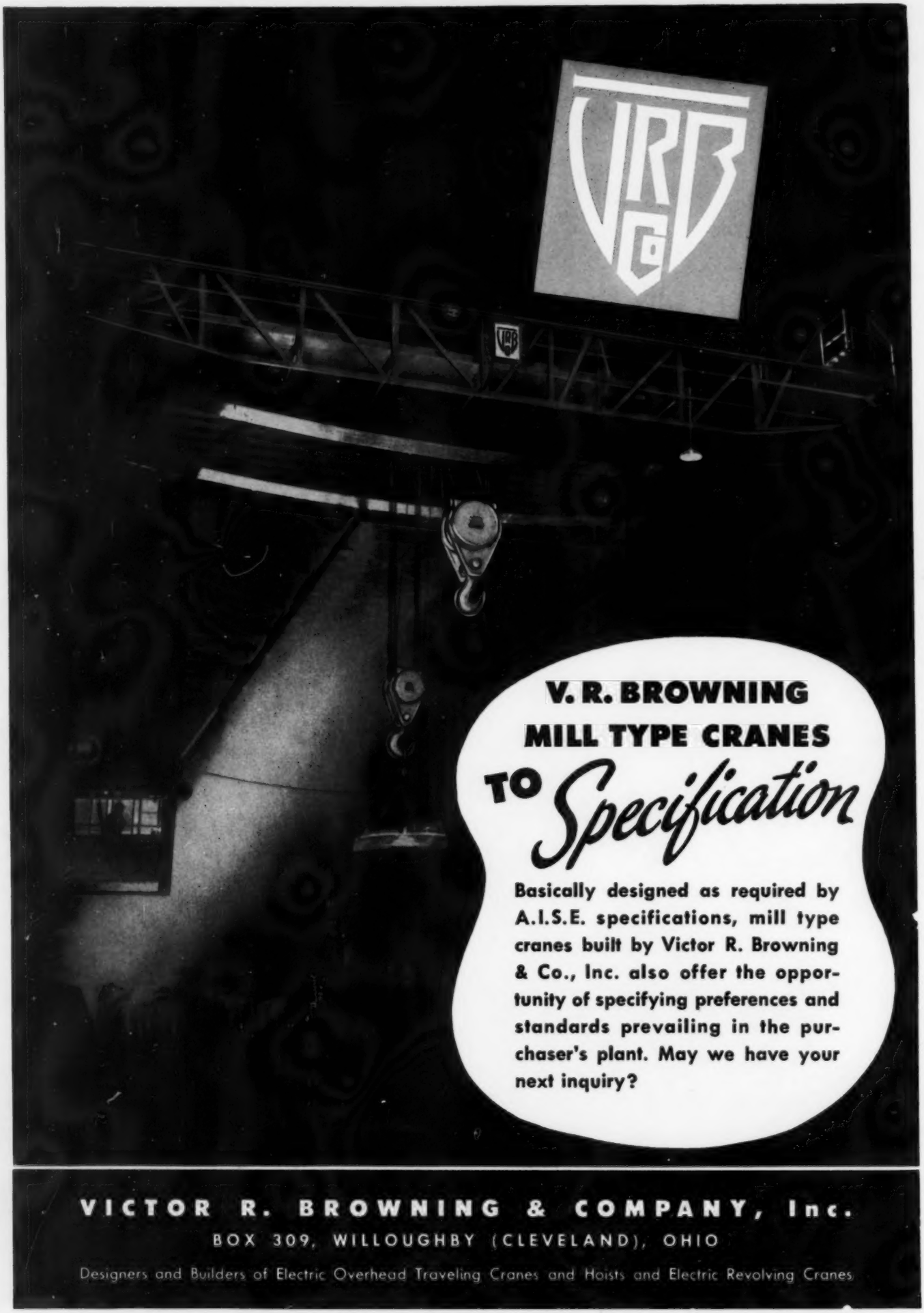
And, of course, our experienced engineers and our manufacturing facilities are always available to help you solve any problem you may have regarding all types of rolling mill machinery.



BLAW-KNOX

BLAW-KNOX COMPANY • LEWIS MACHINERY DIVISION
PITTSBURGH 22, PENNSYLVANIA

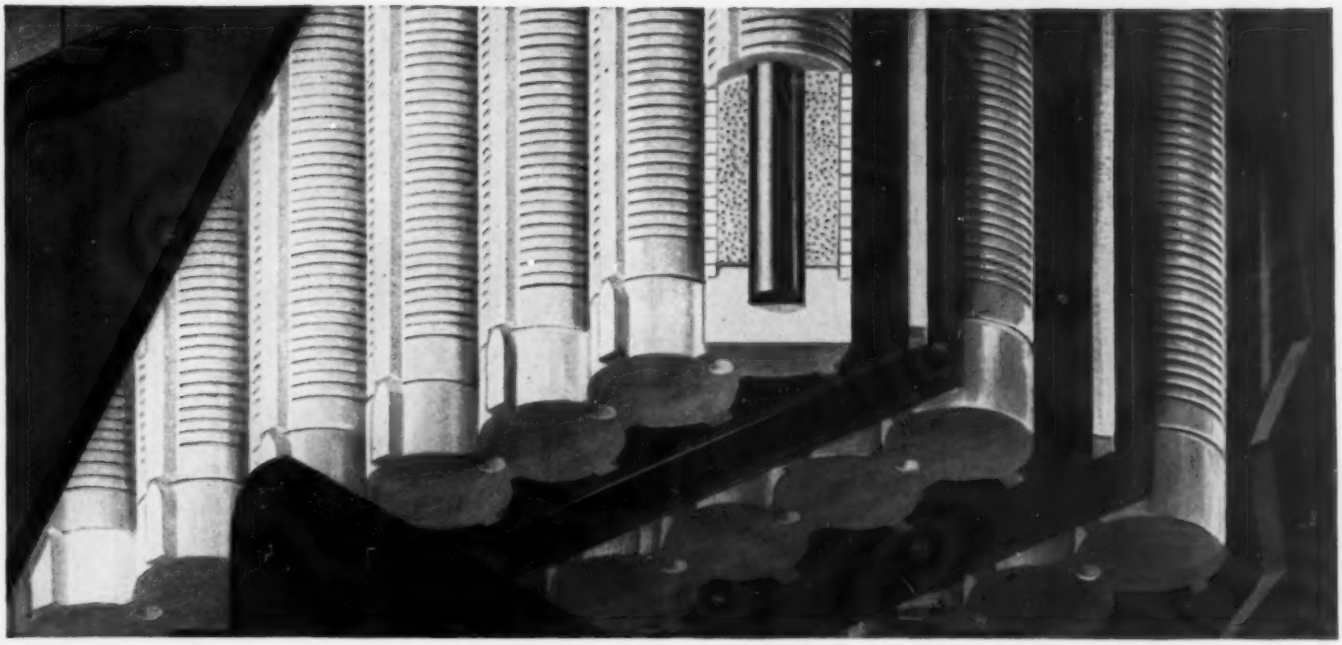
Lewis Products: Two-High Mills • Three-High Mills • Four-High Mills • Bar and Billet Mills • Rod Mills • Coilers • Tables • Shears • Levelers • Pinion Stands • Gear Drives • Roll Lathes • Flaking Mills • and all types of auxiliary mill equipment

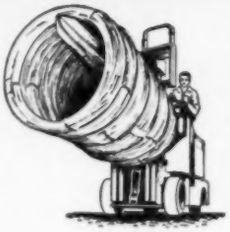

V. R. BROWNING
MILL TYPE CRANES
TO Specification
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?
VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

For industrial trucks . . . Exide-Ironclad now offers

★ 20% more capacity in the same space

★ Lowest cost per A.H. to own and operate





This cutaway picture shows the inside of the new T H EXIDE-IRONCLAD Battery.

Its larger positive plates, containing corrosion-resistant Silvium, are different . . . unique . . . exclusive! No other type of positive plate construction offers you the advantages of the T H Exide-Ironclad, with its slotted plastic tubes, permanently sealed on the bottom with polyethylene tube sealer. More active material is exposed to the electrolyte, resulting in greater power. More active material is retained, providing higher battery capacity for a longer working life. Other features include improved negative plates . . . practically indestructible Pormax separators . . . new sealing compound . . . shockproof molded jar . . . unbreakable quarter-turn vent plugs of plastic . . . corrosion-resistant tray coating.

All of the features of the new T H Exide-Ironclad Battery construction provide direct operating-hour savings for you.

Now-more than ever before...
YOUR BEST POWER BUY AT ANY PRICE!

1888... DEPENDABLE BATTERIES FOR 66 YEARS... 1954

The new T H Exide-Ironclad BATTERY

Thrifty Hauler

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 2 • *Exide Batteries of Canada, Limited, Toronto*
"EXIDE", "EXIDE-IRONCLAD", "SILVIUM", "PORMAX", *Reg. T.M. U.S. Pat. Off.*

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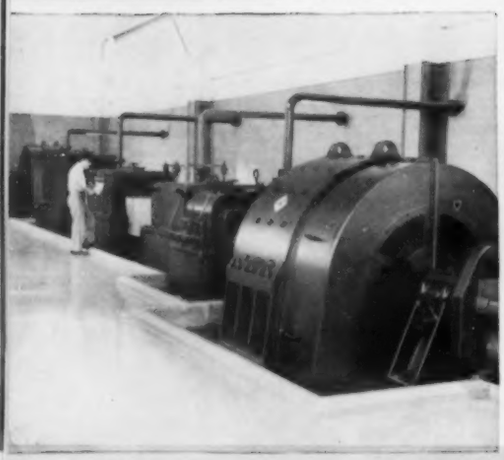
Continental Steel's

Now in Operation

ALLIS-CHALMERS

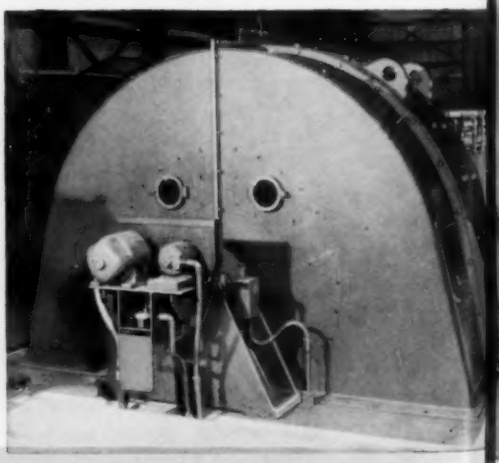
Rolling Mill Equipment

Motor room for continuous rod mill. Allis-Chalmers equipment, including drive motors, series exciter sets, *Regulex* sets, switchgear, motor-generator sets and transformers, furnishes coordinated power to hold precision speeds required in rod mill operation.



Roughing stand drives in the motor room. The 400-hp, 300/900-rpm dc motor in the background drives stands 1 and 2, and the 1500-hp, 300/750-rpm dc motor in the foreground drives roughing stands 3 through 8.

Intermediate stand drives in motor room. Three of the four 800-hp, 300/900-rpm dc motors driving stands 9 through 16. Larger rods are taken directly from these stands without passing through the finishing stands.



Finishing stand drive in the mill proper. This Allis-Chalmers 2000-hp, 300/600-rpm dc motor drives stands 17 through 22. Any number of these six stands may be used to run a variety of small rod sizes.

NEW ROD MILL
at Kokomo, Indiana

AN IMPORTANT PART of Continental Steel Corporation's expansion program to satisfy growing demands for their wire products is the specially designed Allis-Chalmers equipment controlling and driving the 22 stands in this all-new continuous rod mill.

Allis-Chalmers motors and controls are responsible for furnishing the precision speeds required in processing rod from billet to finished product. Each stand must be perfectly coordinated with the others to receive and pass rod from a starting speed equal to a walk and progressing to a finishing speed approximating 60 miles per hour.

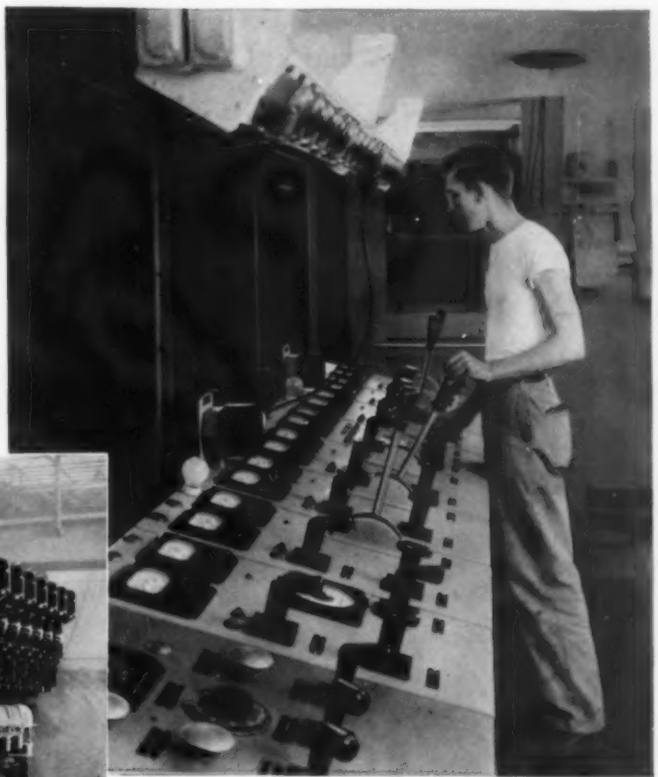
Simplified Control

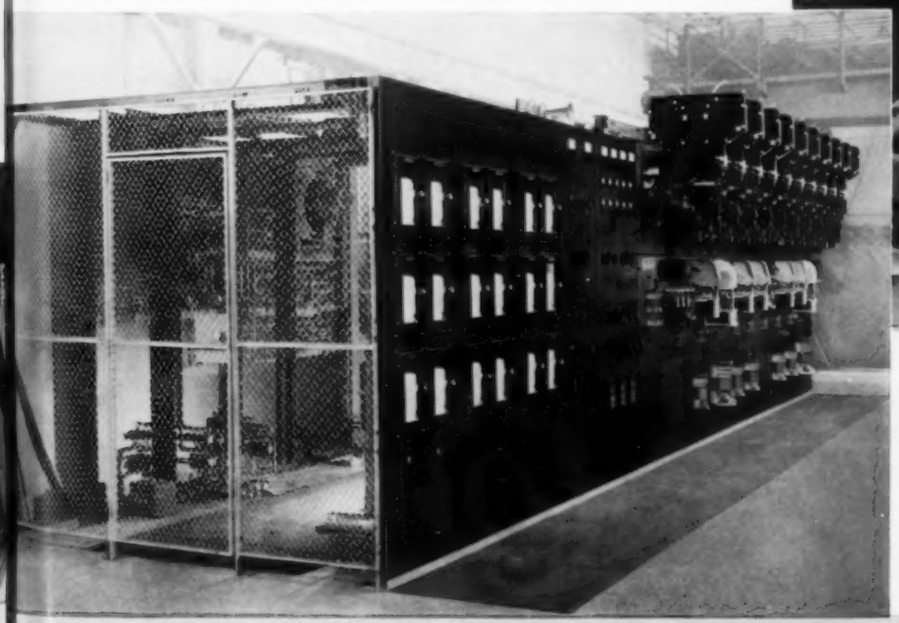
The seven drive motors are standard rolling mill types, engineered to meet the mill requirements and to operate through a simplified speed control system regulating motor field circuits with individual series exciters. Satisfactory mill operation, running three rods simultaneously, has produced 24 coarse and fine rod sizes from 0.218 to 0.681 inch, with projected use up to 1.125 inches.

This mill system gives Continental the benefits of flexibility and adaptability, with quality control not limited to a particular product size. Simplified control and durability are features Allis-Chalmers engineers have used to assure low maintenance costs.

For specific information on control, drives, and other electrical equipment to meet the needs of your expansion or conversion program, contact A-C office nearest you or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-4151

Regulex is an Allis-Chalmers trademark.





Pulpit control for rod processing. From this vantage point the operator controls stand speeds varying from 38 to 114 feet per minute at the start of roughing, to finishing speeds of 5000 feet per minute.

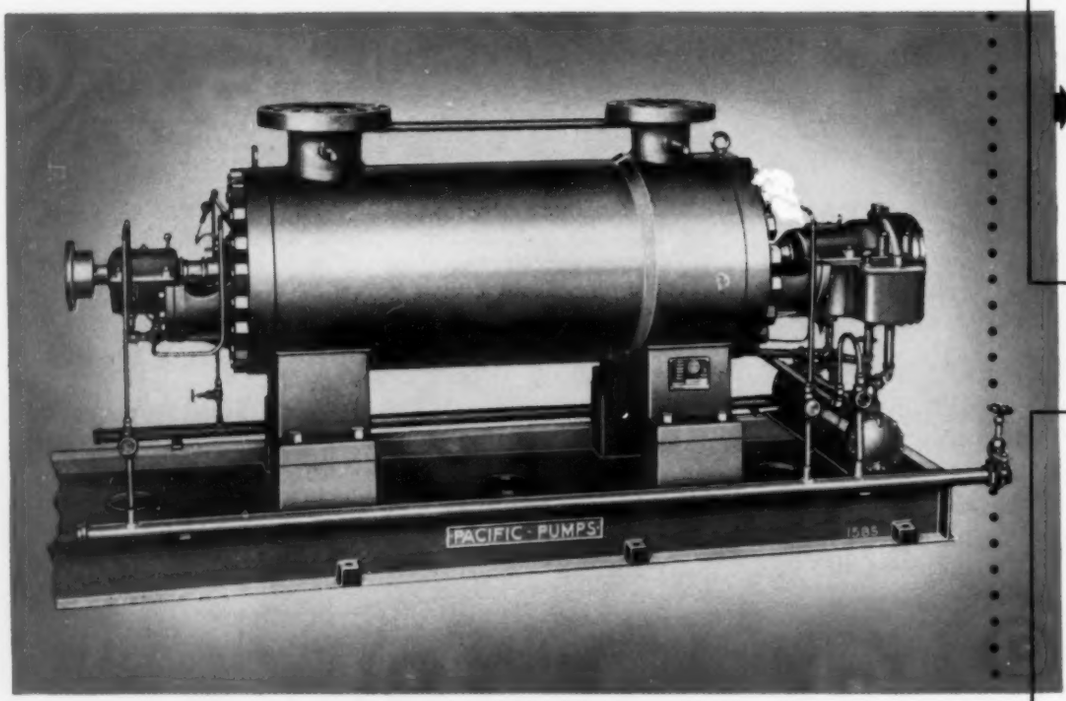
Variable voltage control panel (left) in the motor room for the main drive motors.

ALLIS-CHALMERS

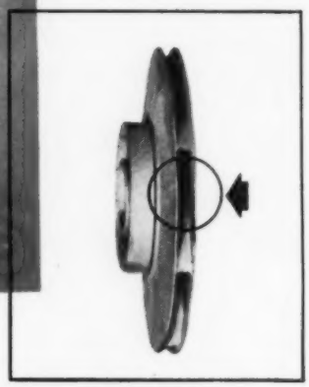
A-C ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Iron and Steel

What will Pacific CENTRIFUGAL PUMPS *do for you?*



THE NEW
New impeller ready for installation.



THE WORN
Impeller after 11 years' service.

● *They will last and last . . . give you years of trouble free service!* Pacifics are built in types to meet your requirements . . . they will deliver up to 2700 gallons per minute of cold or hot water at discharge pressures up to 3000 pounds per square inch.

Their strength and toughness is created by using carbon and alloy steels. The bearings for multi-stage pumps are pressure lubricated. Bearings for all types are sealed against dust and dirt. The result is less down time, fewer replacements and much longer pump life. Pacific Pumps *set new service records*—time after time.

PACIFIC *Precision Built* PUMPS

Pacific Pumps inc.
ONE OF THE DRESSER INDUSTRIES
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Export Office: Chanin Bldg., 122 E. 42nd St., New York—

1S-1

UNITED

35,000 TON FORGING PRESS

A NEW 35,000 ton hydraulic forging press being built by UNITED for the USAF Heavy Press Expansion Program to help bring the United States to a commanding position in the production of modern aircraft for the armed services.

UNITED

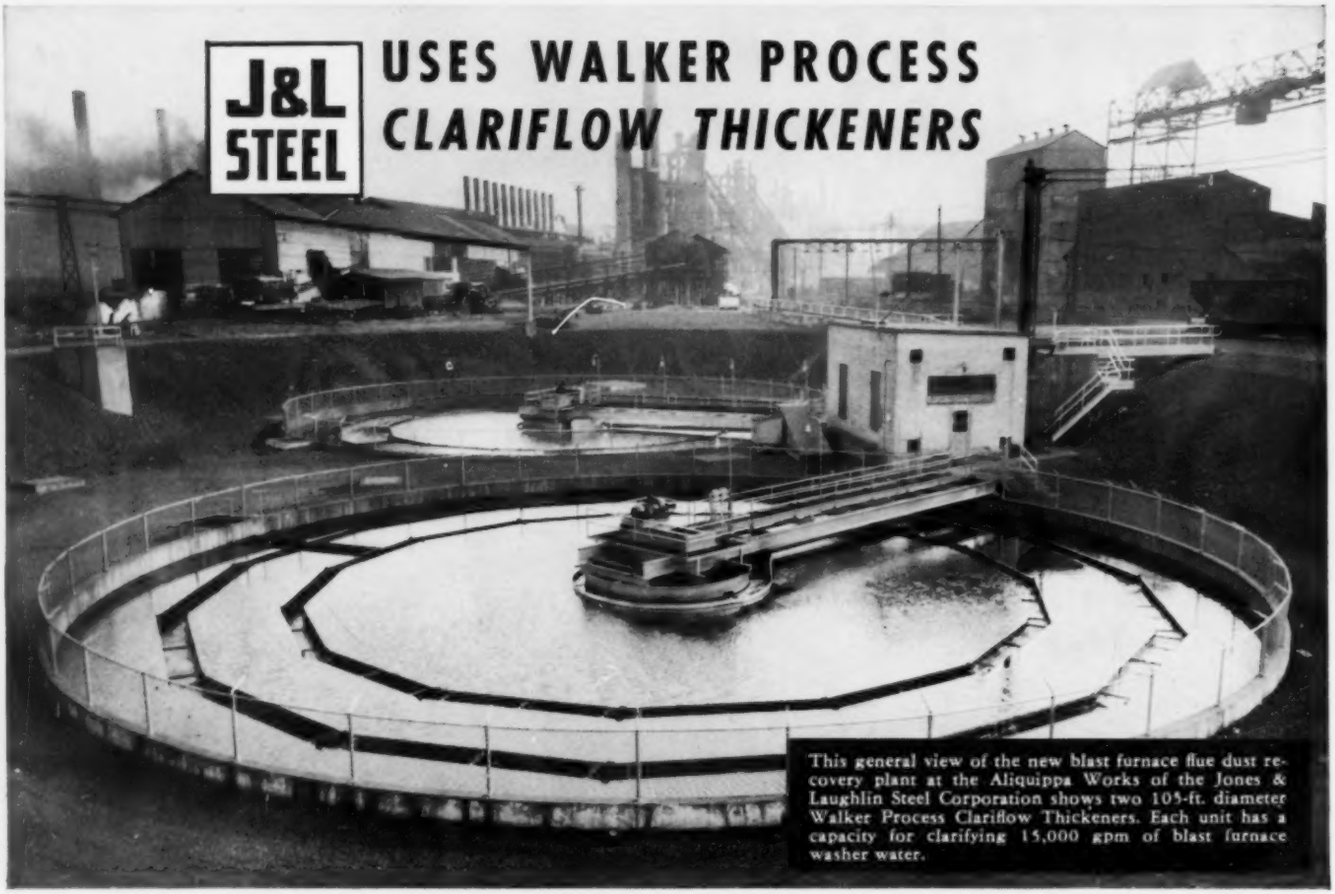
ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton

Subsidiaries: Adamson United Company, Akron, Ohio
Lobdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.



This general view of the new blast furnace flue dust recovery plant at the Aliquippa Works of the Jones & Laughlin Steel Corporation shows two 105-ft. diameter Walker Process Clariflow Thickeners. Each unit has a capacity for clarifying 15,000 gpm of blast furnace washer water.

NEW BLAST FURNACE FLUE DUST RECOVERY PLANT

Removes Over 95% of Settleable Solids!

Single stage thickeners used

Two single stage Clariflow Thickeners were used in the Jones & Laughlin Steel Corporation Aliquippa Works for the following three jobs: (1) to remove over 95% of the settleable solids, (2) clarify the flow to less than five grains and (3) to thicken "mud" to within 40-50% for filtration.

Thickeners have inlet diffusers

The Clariflow Thickener is constructed for rugged use and is capable of overloading without work stoppage. It is provided with a multiple tangential inlet diffuser so that the flow of material entering the unit is uniformly diffused in a rotating manner.

"Short circuiting" at inlet prevented

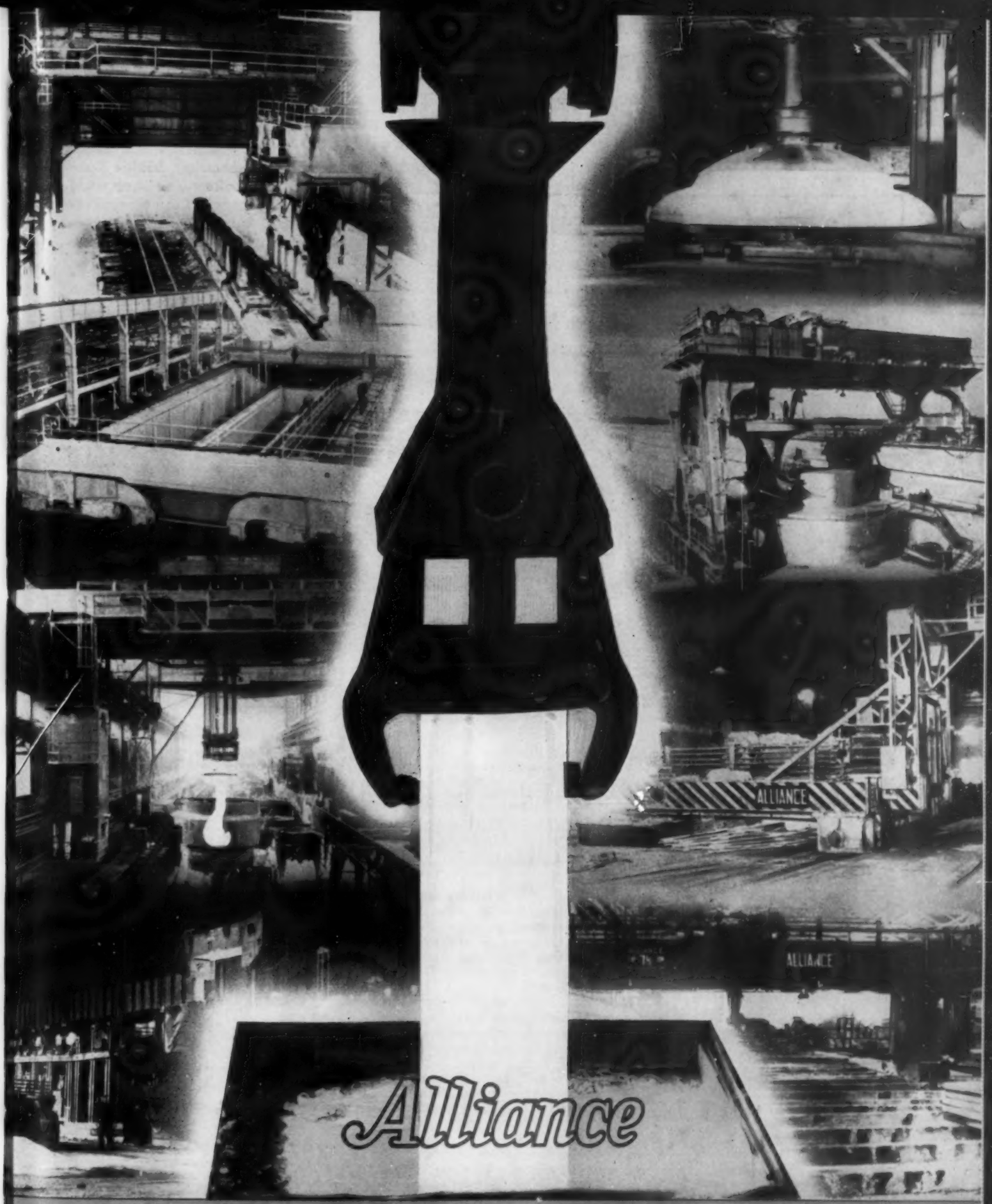
Balanced rotation at the inlet of the Clariflow Thickener prevents short circuiting and the multiple weir troughs spaced over the entire rise area insure uniform slow rise to the surface of the water being clarified. This assures a clarified overflow containing the least amount of solids.

WRITE FOR BULLETIN 10I69

WALKER PROCESS

CLARIFLOW
thickeners

WALKER PROCESS **WALKER PROCESS EQUIPMENT INC.**
FACTORY • ENGINEERING OFFICES • LABORATORIES
AURORA • ILLINOIS



THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

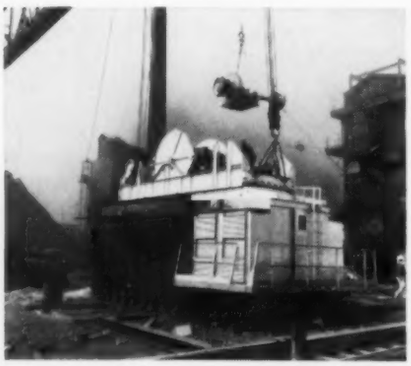
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

NEW DRAVO LIGHT-WEIGHT MAN TROLLEY INSTALLATION BROUGHT THESE RESULTS AT PITTSBURGH COKE & CHEMICAL . . .

	NEW TROLLEY	OLD TROLLEY
Bucket Ore Load	8½ tons	5 tons
Operating Cycle	50 seconds	60 seconds
Free-digging Tonnage	600 tons/hr.	300 tons/hr.

Early in 1952, engineers at Pittsburgh Coke & Chemical Company foresaw a materials-handling problem which would arise when a new blast furnace was added to the plant's facilities. The existing materials-handling bridge would be unable to keep up with expanded operations when the new furnace began functioning. Dravo engineers were called in to discuss the problem.

The result was a decision to install a new Dravo light-weight man trolley which would permit using a larger bucket. This increased the bridge's capacity at ⅛ the cost of a new bridge. Installation time was only 13 hours. Here is how it was done.



1 Designed and constructed by Dravo Corporation, the new man trolley was blocked on cribbing below the bridge. Each axle was lifted 75 ft. to the trolley runway.

2 Both axles were left suspended above the runway until the trolley frame with its attached machinery house and operator's cab was hoisted, placed on runway rails and supported with the trolley jacking lugs.

3 The trolley frame was hoisted into place by steam-driven block-and-tackle. The trolley's all-welded construction with liberal amounts of aluminum used in the machinery house and operators' cab greatly reduced its weight.

4 It took only 13 hours to install the new trolley and remove the old one. With the short time the bridge was out of service, production of the two blast furnaces at the plant was not interrupted.

The installation of a Dravo light-weight man trolley on existing materials handling structures still in good structural condition is the practical way to increase the capacity of ore and coal bridges to meet growing production requirements.

The weight saving factors of the new trolley are utilized in a larger capacity bucket without increasing the over-all load on the bridge. Some of the weight-saving factors include: All-welded frame of corrosion-resistant alloy steel, an aluminum sheathed machinery house and operator's cab, heat treated axles and the use of high-strength alloy components elsewhere.

A new Dravo light-weight man trolley can step up your bridge performance. If you have a materials-handling problem, we will be glad to discuss it with you and suggest a logical solution.

DRAVO

DRAVO

CORPORATION

NEVILLE ISLAND, PITTSBURGH 25, PENNA.

●

DESIGNERS and BUILDERS

Bridges and Unloaders • Tower-type Unloaders
Whirler Cranes • Floating Cranes
Dravo Rail Clamps • Barge Shifters
Modernized Trolleys for Existing Bridges

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period September 15 through October 6, 1953 . . . .

METHOD OF FORMING BIG END UP INGOTS

▲U. S. 2,654,144, issued October 6, 1953 to George A. Dornin and assigned to George A. Dornin, Jr., relates to big end up ingots of killed steel which do not employ a hot top. This patent is an improvement over previous ones by the same inventor, U. S. 2,021,227 and 2,585,096.

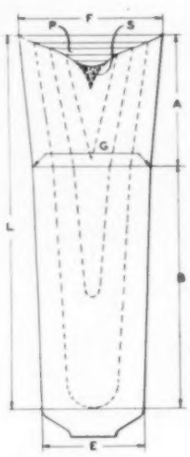


Figure 1

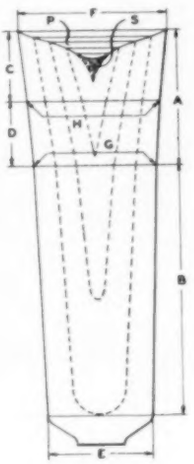


Figure 2

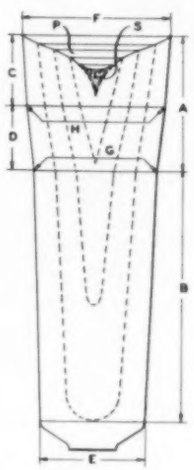


Figure 3

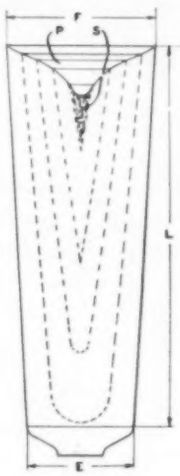


Figure 4

In the present invention, a compromise between the advantages of large taper and small taper is obtained by employing a multiple or non-uniformly tapered ingot, the taper in the upper portion being greater than that in the lower portion. The upper portion may have a single taper as shown in Figure 1 or a multiple taper as shown in Figures 2 and 3.

The advantages of employing a multiple tapered ingot may be seen by comparing the above figures with Figure 4 which shows an ingot having a continuous or uniform taper throughout its length. All the ingots shown in Figures 1-4 have the same bottom and top dimensions E and F and the same body length L. Lines of progressive solidification are shown on all four ingots and the zone of unsound metal including the segregate zone is indicated. It will be noted that the depth of the pipe cavity P and of the segregated zone S in the multiple tapered ingots are less than those in the uniformly tapered ingot. This is true because the multiple tapered ingots have smaller volumes than the uniformly tapered ingot while the top areas are the same. That is to say, by the use of multiple tapers, it is possible to use a relatively heavy taper at the top in order to secure a shallow segregate zone, without resulting in a very small bottom cross-section and a great difference between the rates of metal rise in the lower and upper parts of the ingot. The latter would be objectionable because it tends to produce a thin tender skin which often tears during forging or rolling.

It has been found that the length of the heavily tapered upper portion should be between 30 and 40 per cent of the length of the ingot. The per cent taper in the upper portion should be between 13 and 22 per cent, and should be between 1.4 and 1.8 times the overall per cent taper.

STOCK GUIDE FOR ROLLING MILLS

U. S. 2,651,955, issued September 15, 1953 to William J. Fisher, relates to stock guides for rolling mills. Figure 5 is a top plan view of the apparatus; Figure 6 is a perspective view on an enlarged scale of one of the roller mountings, and Figure 7 is a sectional view taken on line 3-3 of Figure 6.

The numeral 5 designates a mounting frame consisting of a top 6, bottom 7, and a pair of end walls or spacers 8 rigidly fixed to each other. A pair of U-shaped channels 9 are positioned on their sides in the front of mounting 5 and are pivoted for horizontal swinging movement on pins 10. These pins are retained in the mounting by locking keys 11 fitted in a keyway 12 in the upper part of the pins, the keys resting on the top of the mounting. Spacing washers 13 are positioned on the pins between the top of the fixture and the top 6 of the mounting, and also between the bottom of the fixture and the bottom 7 of the mounting.

A pair of rollers 14 are mounted in the open front of each of the fixtures on vertical pins 15, with the rollers protruding beyond the fixtures and mounting. Aligned openings 16 are formed in the top and bottom of the mounting to receive pin 17 of a carrier 18 on an adjusting screw 19 having oppositely threaded portions, whereby a mounting may be positioned at each edge of a metal strip 20, as

it is fed to a metal working machine 21 between the rollers, to adjust the mountings relative to the strip by means of screw 19.

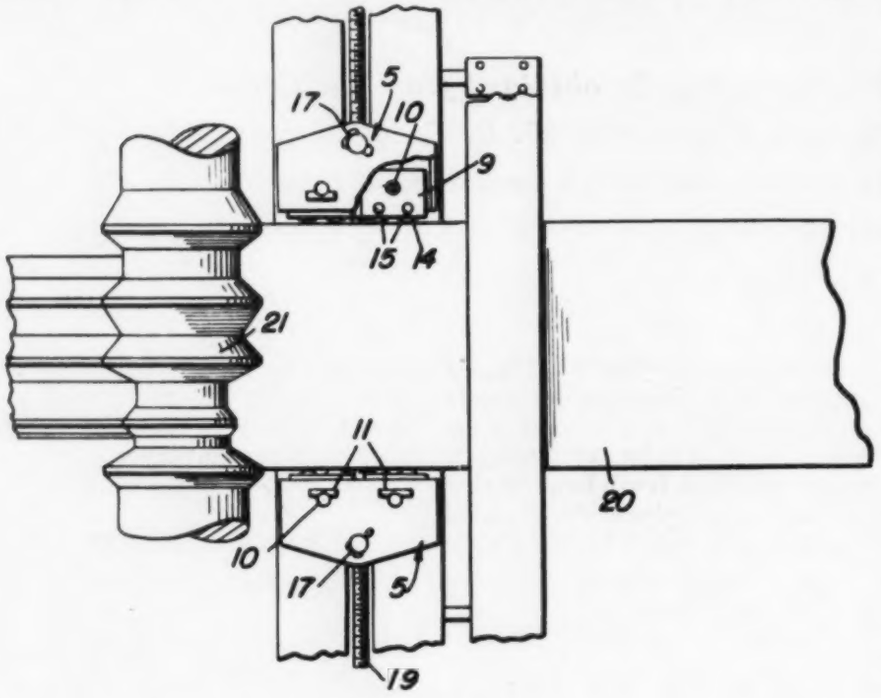


Figure 5

The mountings are free to pivot on the pins 17, and the fixtures 9 for the pairs of rollers 14 are free to pivot on the pins 10 to compensate for a possible defect or inaccuracy in the edge of the strip.

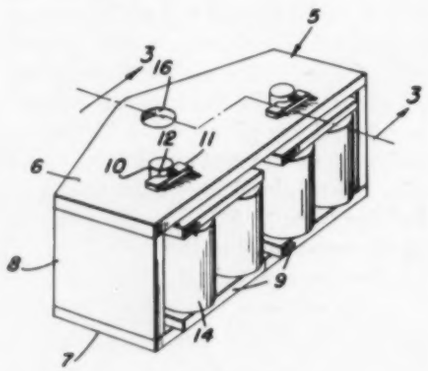


Figure 6

DIRECT PRODUCTION OF STEEL FROM OXIDES OF IRON

In U. S. 2,653,088, issued September 22, 1953 to Robert D. Pike, steel is produced directly from iron ores in a gaseous reduction process without fusion, followed by depositing carbon in the partially reduced ore, and then effecting a substantially complete reduction with fusion in an electric furnace.

The reducing gas is made by reforming natural gas to yield a gas rich in carbon monoxide and hydrogen. After the initial reduction of ore has occurred, carbon is deposited from the reducing gas by cooling it below 1000 F, by the reaction:

$$2\,CO \rightarrow CO_2 + C$$

The object of the invention is to permit the production of steel where coal is unavailable, substituting natural gas as the raw material providing the fuel and reducing agent.

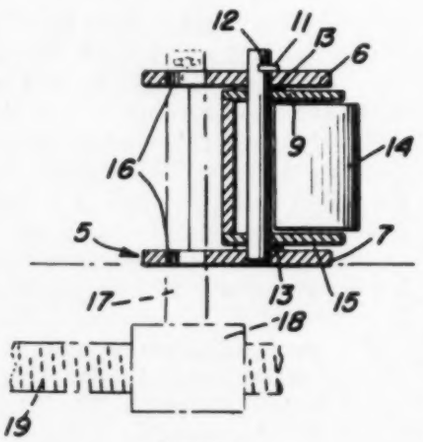


Figure 7

PICKLING OF STEEL

Pickling time can be reduced and the life of pickling solutions increased by a method described by Ralph M. Drews and Harold L. Farling in U. S. 2,653,115. The patent, issued September 22, 1953, is assigned to Republic Steel Corp.

The article is first preheated to 225 to 400 F by the application of a flame, and is then pickled at 180 to 210 F. Very rapid and thorough scale removal is said to result, even if the bath is fouled with ferrous salts and not suitable for pickling in the conventional way.

AUTOMATIC SELF-CENTERING ROLL

U. S. 2,653,814, issued September 29, 1953 to Edwin T. Lorig and assigned to United States Steel Corp., relates to an automatic self-centering roll for centering and aligning metal strip conveyed over rolls. It is likely that the strip will be fed at a slight angle to the roll. Because of this, the strip will work its way across the face of the roll. In addition, the camber or lateral curvature which is present in the finished strip due to rolling difficulties causes the strip edges and longitudinal center line to approach the roll at an angle, this also causing the strip to move across the face of the roll.

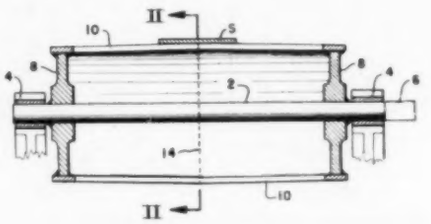


Figure 8

In order to keep the strip in the desired path, various expedients have been tried. One of the most common is the use of stationary or rotatable side guides against which the edges of the strip bear. In some instances, side guides have been used in conjunction with looper pits to force the strip back on the desired line. The use of abnormally high strip tension has also been tried in an attempt to keep the strip aligned. Another method of operation is to periodically slip the strip back into its proper position on the conveying roll. All these methods tend to abrade and mutilate the strip edges. Diagonal or lateral surface scratches are also formed on finely furnished flat products, resulting in a large percentage of scrapping.

Tray of red-hot forged valve blanks from an annealing oven. Notice the special long forks designed for this job.

Weighing load of slugs to determine number of pieces produced. Tote boxes have weight marked on side.

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The new type of apparatus is shown in Figures 8 and 9. The numeral 2 indicates a shaft mounted in bearings 4, and provided with a driving extension 6. Webs 8 are welded to the shaft near the bearings. Leaves 10 are welded to the webs 8.

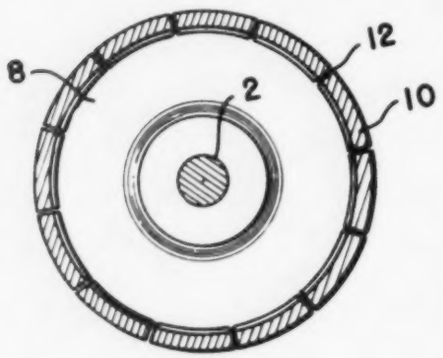

Figure 9

As the roll rotates, the spring-like leaves 10 are slightly expanded by centrifugal force at the center of the roll. When a strip S is passed over the roll, the leaves 10 in contact with the strip are depressed slightly to their static position, thus causing the strip to be centered on the transverse center line of the roll.

SMELTING IRON OXIDE TO PRODUCE HIGH GRADE IRON

In U. S. 2,653,867, issued September 29, 1953 to Thayer Lindsley and Lyall J. Lichty, and assigned to Quebec Metallurgical Industries, Ltd., a method is disclosed for reduction of a high grade iron oxide (free of sulfur and phosphorus) to high grade iron free of impurities such as carbon or silicon.

The oxide is smelted in the presence of a flux such as lime, with a combination reducing agent consisting of finely divided charcoal and a finely divided alloy of aluminum ferrosilicon. The proportions of the reducing agents are such that the carbon content is 45 to 85 per cent in oxidizing power, while the aluminum ferrosilicon content is sufficient to provide 15 to 55 per cent of the oxidizing power. An excess of 20 per cent of the combination reducing agent is sufficient to produce a high purity metal, but excesses up to 40 per cent do not substantially increase the amount of impurities in the product.

The preferred method of smelting is in an electric furnace.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,651,821	9/15/53	Continuous or semicontinuous casting of metals	Imperial Chemical Industries, Ltd.
2,651,822	9/15/53	Mold supporting device	Walworth Co.
2,651,954	9/15/53	Method for cold rolling strip material	Frank P. Dahlstrom
2,651,956	9/15/53	End roll adjustment	Birdsboro Steel Foundry & Machine Co.
2,652,240	9/15/53	Skid rail structure for forge furnaces	Surface Combustion Corp.
2,652,242	9/15/53	Device for cleaning grate bars of sintering machines	The American Metal Co., Ltd.
2,652,324	9/15/53	Cast iron	The International Nickel Co., Inc.
2,652,440	9/15/53	Electric arc melting furnace	The Battelle Development Corp.
2,652,441	9/15/53	Electric melting furnace	Allmanna Svenska Elektriska Aktiebolaget
2,652,605	9/22/53	Automatic shakeout device for tight flask molds	Herbert Simpson Corp.
2,652,606-8	9/22/53	Vibration molding machine	Eduard Mezger
2,652,607	9/22/53	Jolt and draw foundry machine	Spo, Inc.
2,652,609	9/22/53	Method of making molds for precision casting	Westinghouse Electric Corp.
2,652,793	9/22/53	Refractory furnace roof brick resistant to spalling	General Refractories Co.
2,652,811	9/22/53	Power hammer for swaging steel	Hans P. Beche
2,652,934	9/22/53	Machine for separating and delivering metal sheets from a stack	Robert Van Schie
2,653,117	9/22/53	Method of making a cold formed bimetallic shape	Superior Steel Corp.
2,653,371	9/29/53	Casting ejector	Helmer V. Kruse
2,653,392	9/29/53	Foundry drying oven	United States Steel Corp.
2,653,497	9/29/53	Rolling mill turn-up guide	Jones & Laughlin Steel Corp.
2,653,662	9/29/53	Flying shear	United Engineering & Foundry Co.
2,653,674	9/29/53	Flame suppressor for cupolas	Whiting Corp.
2,653,675	9/29/53	Gas cleaning apparatus	George E. Lynch
2,653,883	9/29/53	Combination steel and die casting cleaning process	Ford Motor Co.
2,653,905	9/29/53	Process for total treatment of copper-containing iron pyrites	Pyror Ltd.
2,654,014	9/29/53	Inert-arc welding of stainless tubing	Republic Steel Corp.
2,654,587	10/ 6/53	Roll seal for use at entrance or exit of a heat-treating chamber	Selas Corp. of America
2,654,591	10/ 6/53	Treating furnace for metallurgical purposes	Peter Schmidt
2,654,593	10/ 6/53	Reverberatory furnace for heat-treating	Dee A. Knight
2,654,669	10/ 6/53	Reduction of iron oxides in a rotating batch furnace	Combustion Processes Co.
2,654,683	10/ 6/53	Alloy steel	Bower Roller Bearing Co.

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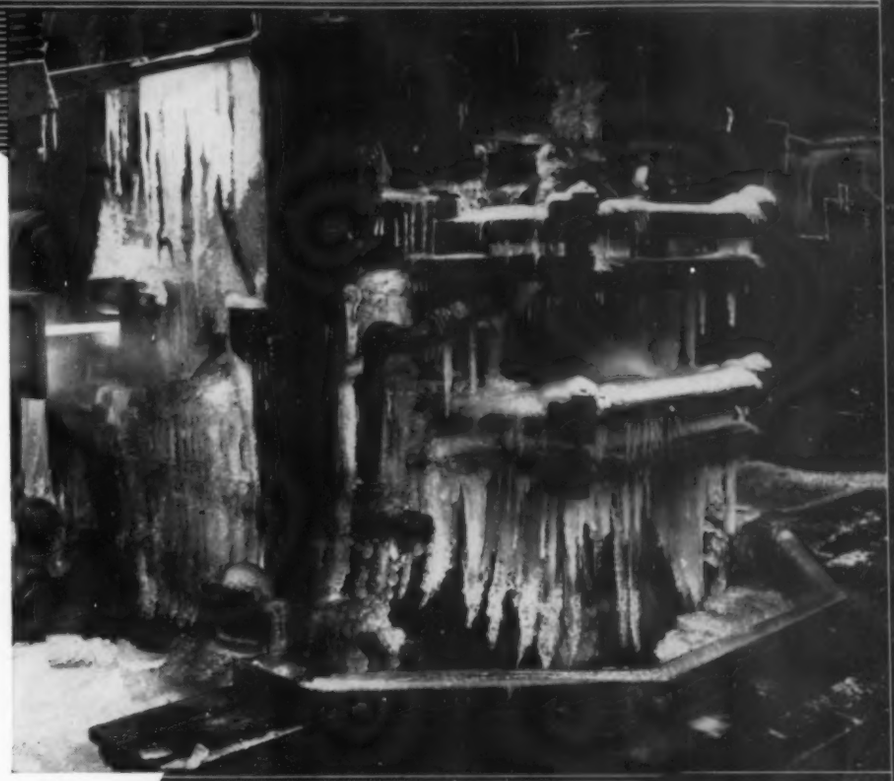

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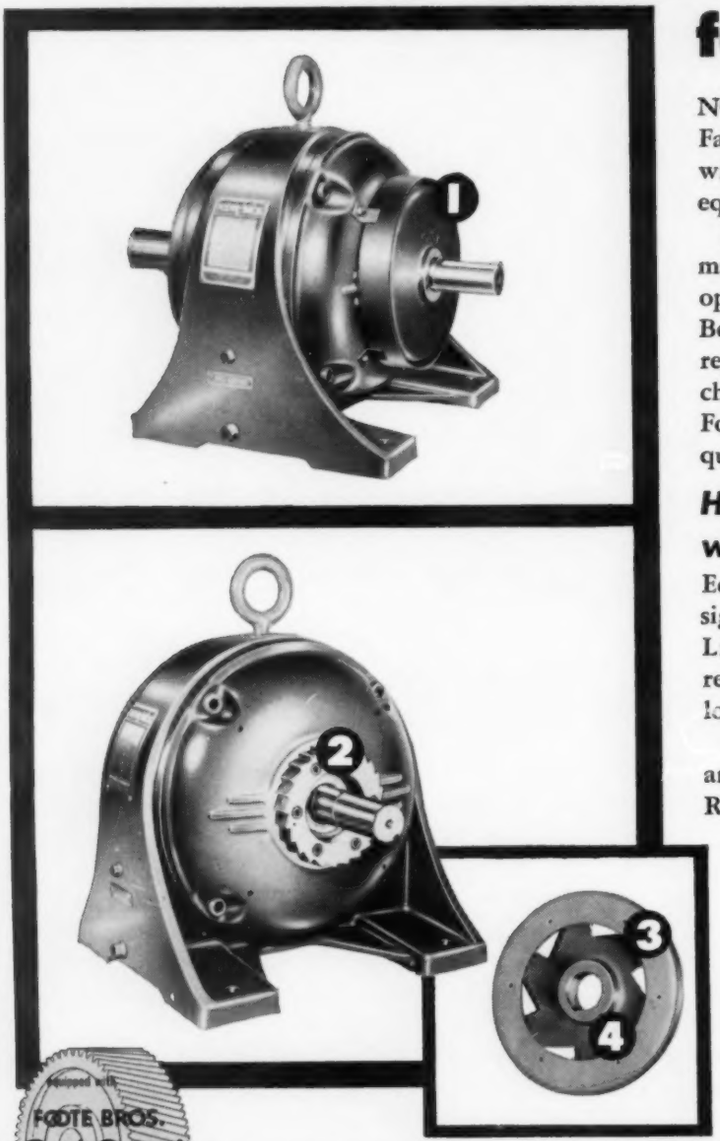

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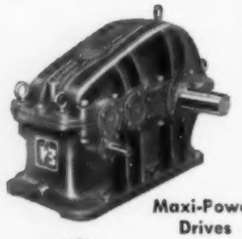

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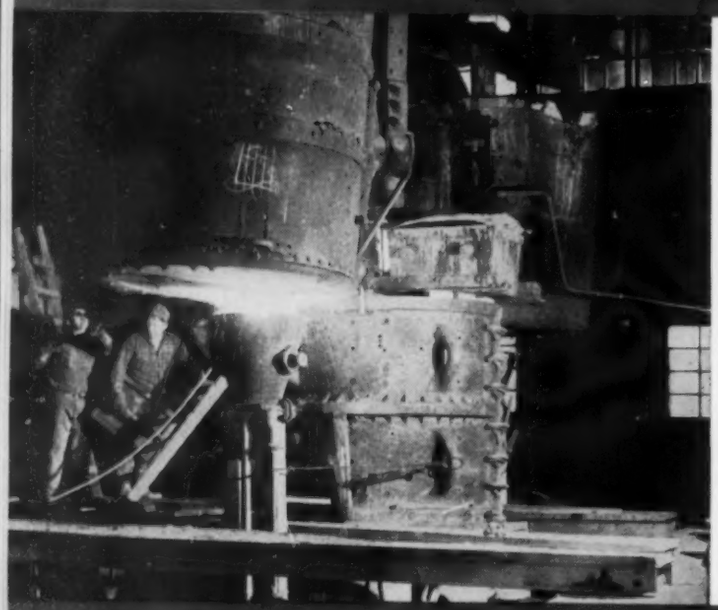

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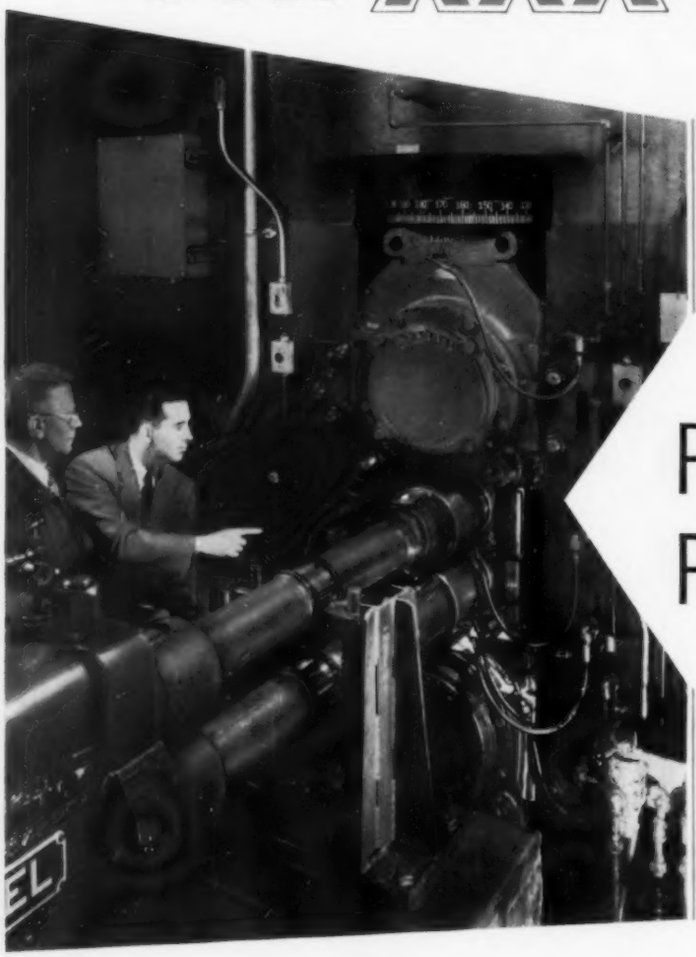

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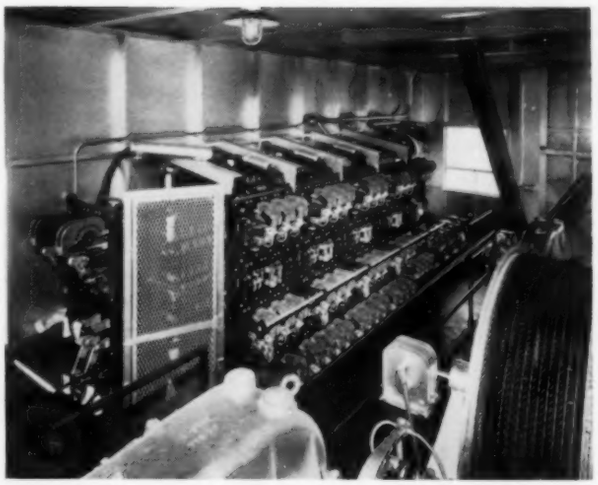

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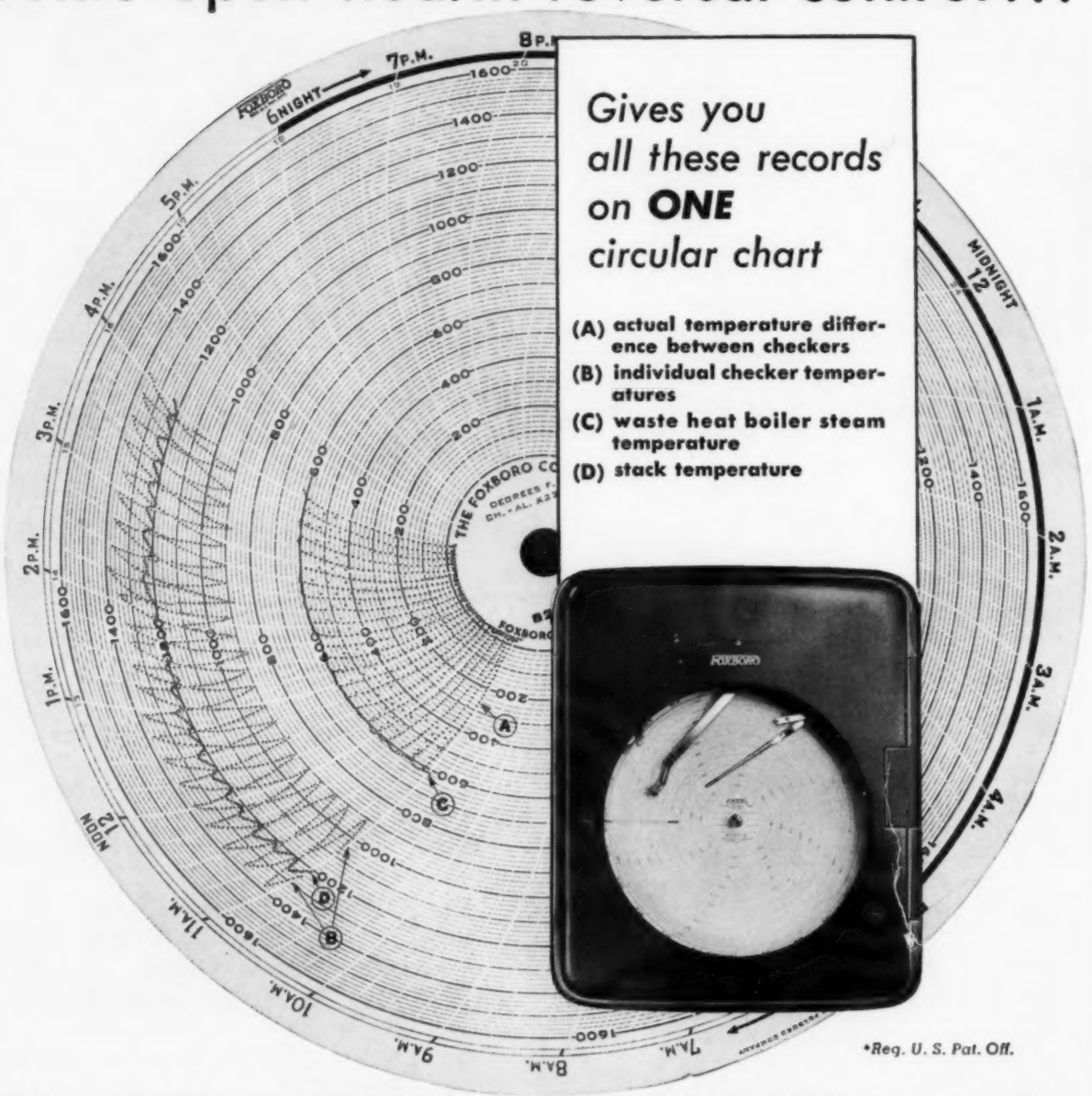

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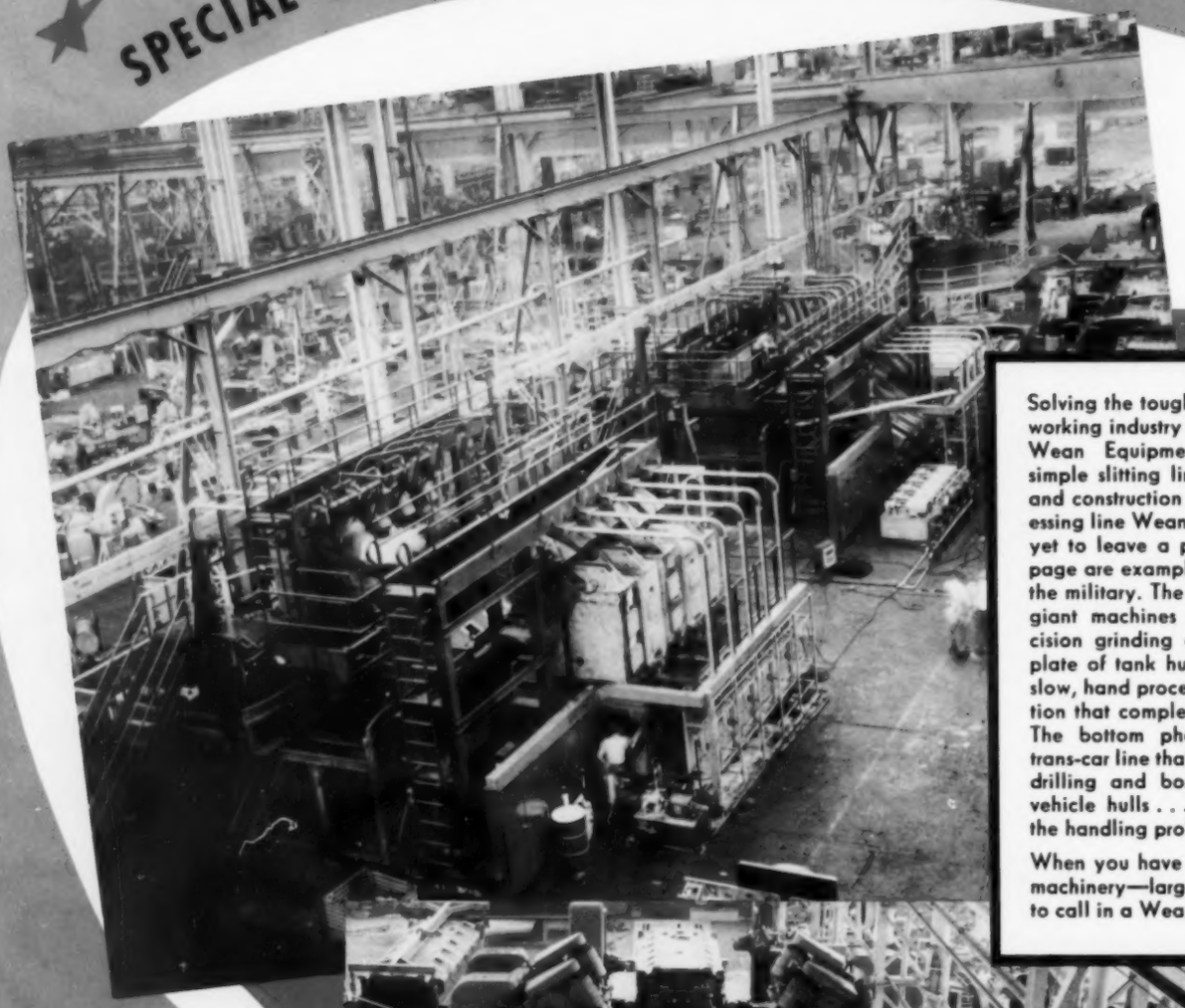

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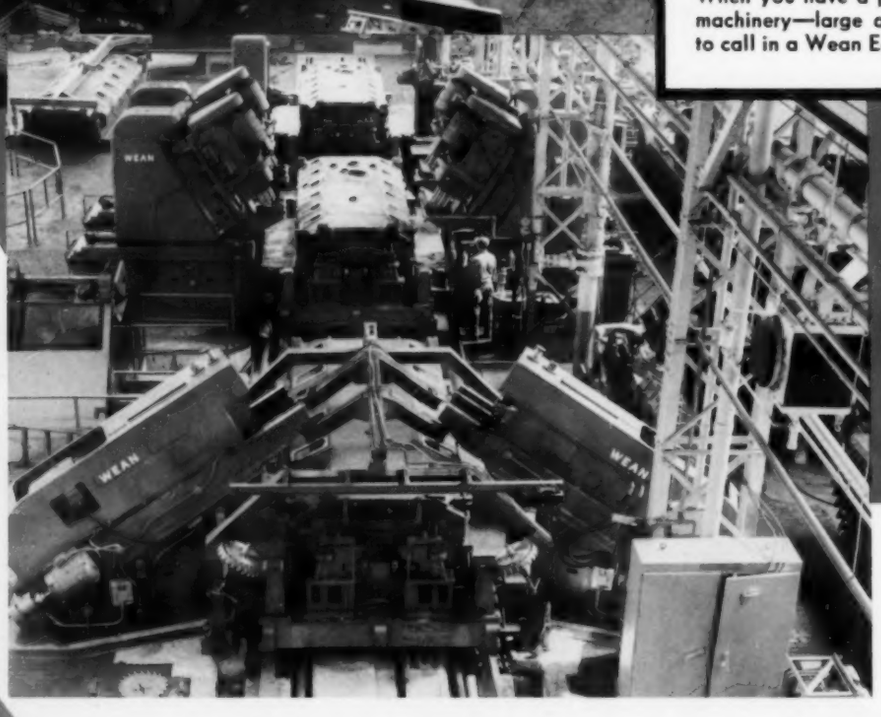

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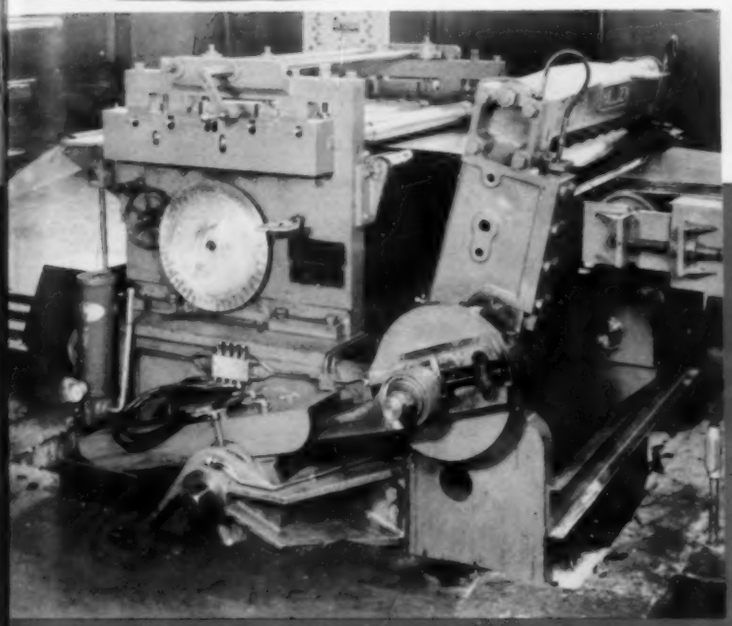
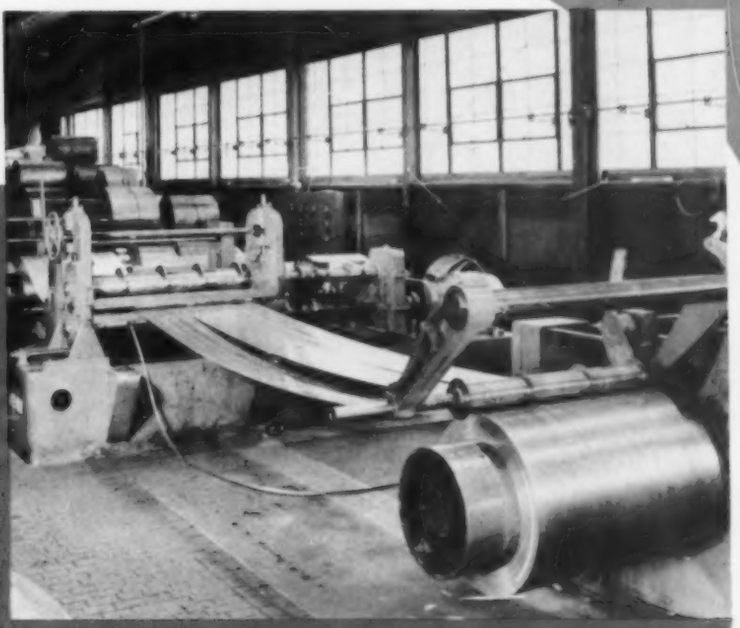
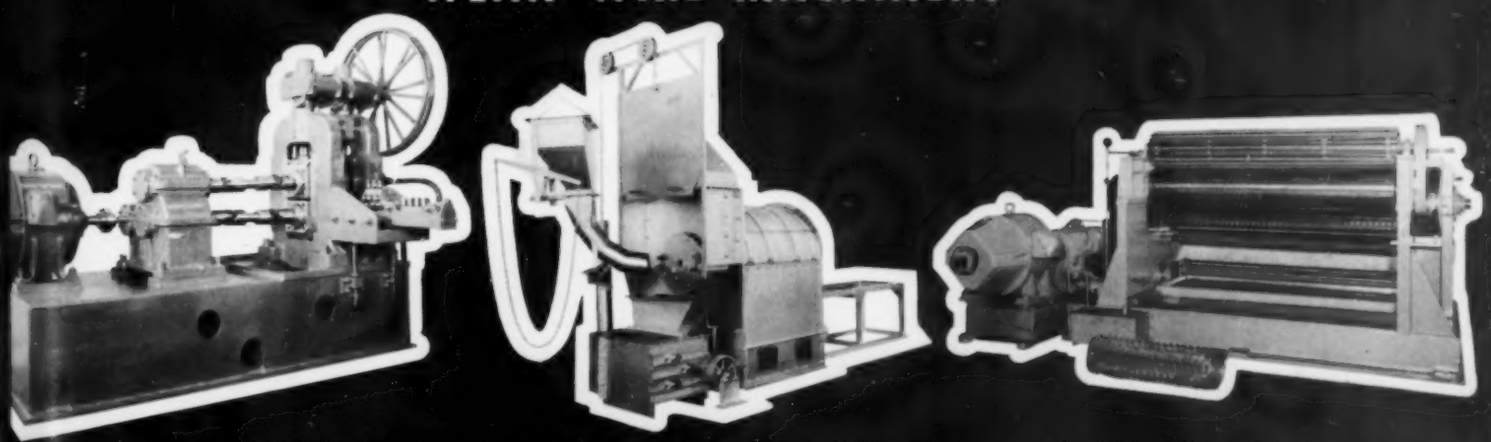




Here's the most advanced flying shear line marketed today. A line that can save you up to 20 per cent on your steel costs because it can make 100 cuts-per-minute to resquared tolerances. If you are a user of sheet steel it will more than pay you to get in touch with a Wean Equipment engineer and have him prove to you how you can order your steel direct from the mill, in coil form, eliminate expensive extras, and make a saving amounting to almost $20 per ton in your final steel costs. You can't afford to overlook this amazing new line . . . get in touch with Wean Equipment in Cleveland, Chicago or Detroit.

WEAN WIRE MACHINERY



an Equipment has for years been the or producer of wire machinery, and has "know-how" to design and build ma-es to speed wire production and proc-essing all along the line. If you make wire or wire products you should know the Wean Equipment man in your area. Products pic-tured here are typical of Wean wire ma-chinery; a 2-hi wire flattening mill, a nail galvanizing unit, and a hexagon netting machine that holds all records for the manu-facture of this popular wire product.

Wean high speed electrolytic cleaning line.

WEAN
ENGINEERING
Company, Inc.
WARREN, OHIO

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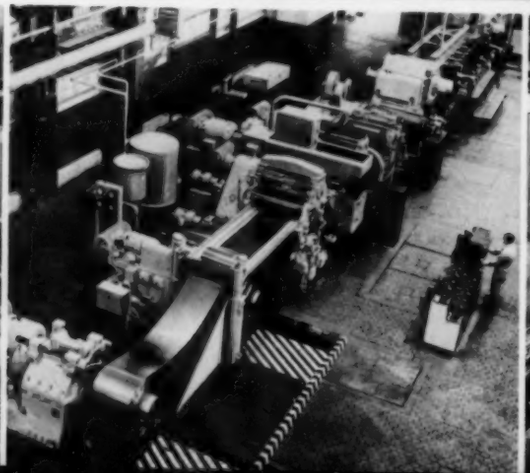
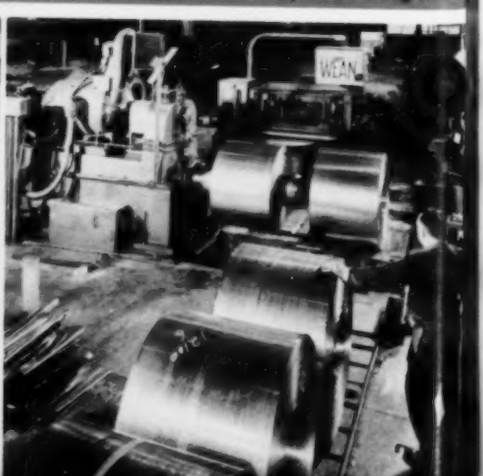
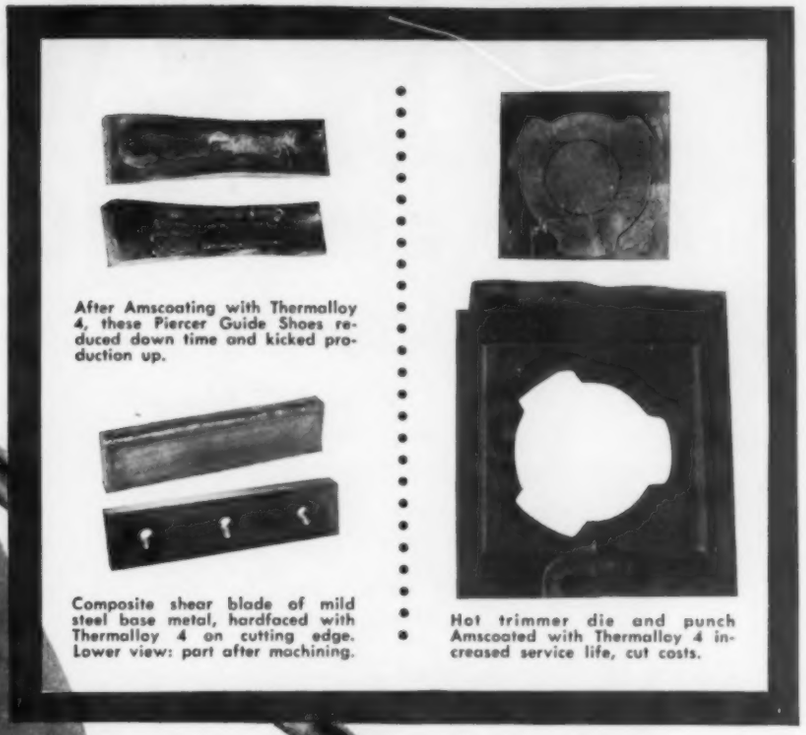
Continuous strip pickle line

Continuous coating line



Continuous electrolytic cleaning line





After Amscoating with Thermalloy 4, these Piercer Guide Shoes reduced down time and kicked production up.

Composite shear blade of mild steel base metal, hardfaced with Thermalloy 4 on cutting edge. Lower view: part after machining.

Hot trimmer die and punch Amscoated with Thermalloy 4 increased service life, cut costs.

BEAT HEAT WEAR and IMPACT with AMSCO THERMALLOY 4

If you have a wear problem involving high temperatures and requiring resistance to impact, this new Amsco hardfacing electrode can save you time and money

Elevated temperatures are tough to cope with in situations involving thermal shock, metal-to-metal wear, hot gas corrosion, high temperature oxidation—especially when you need great impact resistance. Here's where Amsco Thermalloy 4 can step in and give you longer service life, and big savings in time and money.

Supplied as both a composite coated electrode for electric welding or as a bare cast rod for gas welding, both types deposit a high-carbon stainless alloy containing chromium and nickel as the principle alloying elements. In many applications, it can replace expensive nickel base alloy materials. Thermalloy 4 is packaged in 50-lb. boxes or in 10-lb. packages in 50-lb. boxes. For detailed analyses and other pertinent information, write for catalog sheet on Thermalloy 4 or contact your nearest Amsco distributor.

AMSCOATING

THE RIGHT WAY TO SAY HARDFACING

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION

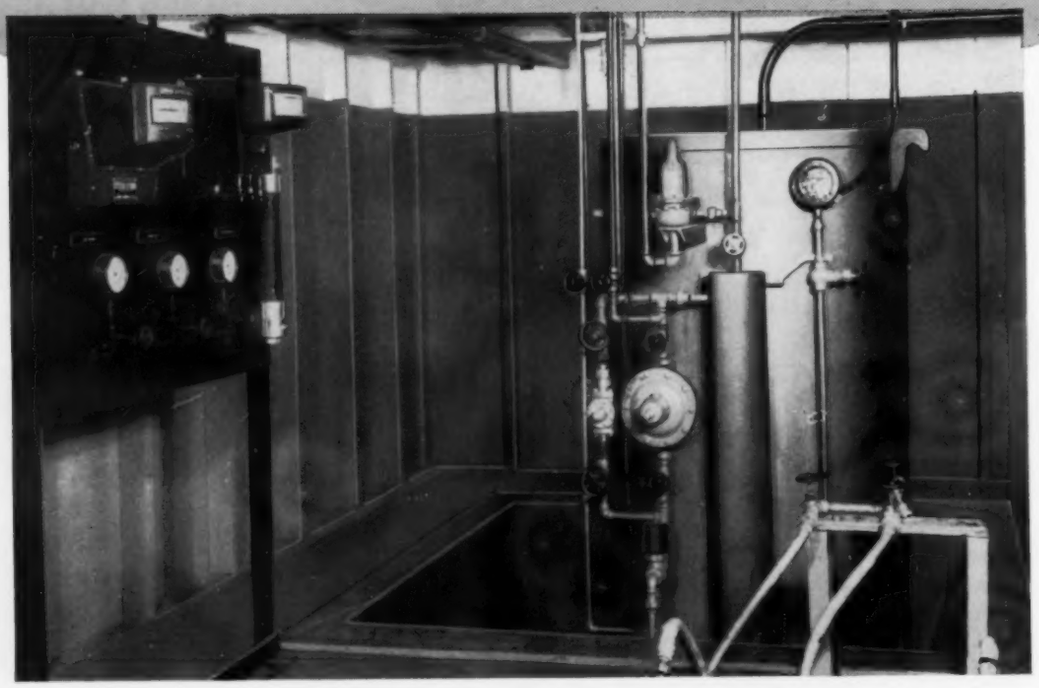
411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliettette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

DREVER

AMMONIA DISSOCIATOR

produces the ideal protective furnace atmosphere



Shown at right is Drever 1000 CFH Ammonia Dissociator — panel complete with flow meter, pressure gauge, over-temperature protection instruments and temperature control, which is now furnished flush mounted.

"CRACKED" AMMONIA SHOWS TREMENDOUS COST SAVING and UNSURPASSED PERFORMANCE

1—Bright Annealing — Stainless Steels, Nickel and Nickel Alloys, Beryllium Copper, Silicon Copper Alloys and Bronzes, and high and low carbon steels.

2—Clean Hardening — High carbon and high chrome tool steels.

3—Copper Brazing of all types of ferrous metals.

4—Sintering of Powdered Metal Parts.

5—Reduction of Metal Oxides.

6—Bright Annealing of Electrical Steels.

7—Atomic Hydrogen Welding

8—Radio Tube Sealing.

We can supply COMPLETE STORAGE SYSTEMS for tank car lots of anhydrous ammonia. This reduces the cost of ammonia approximately 75%.

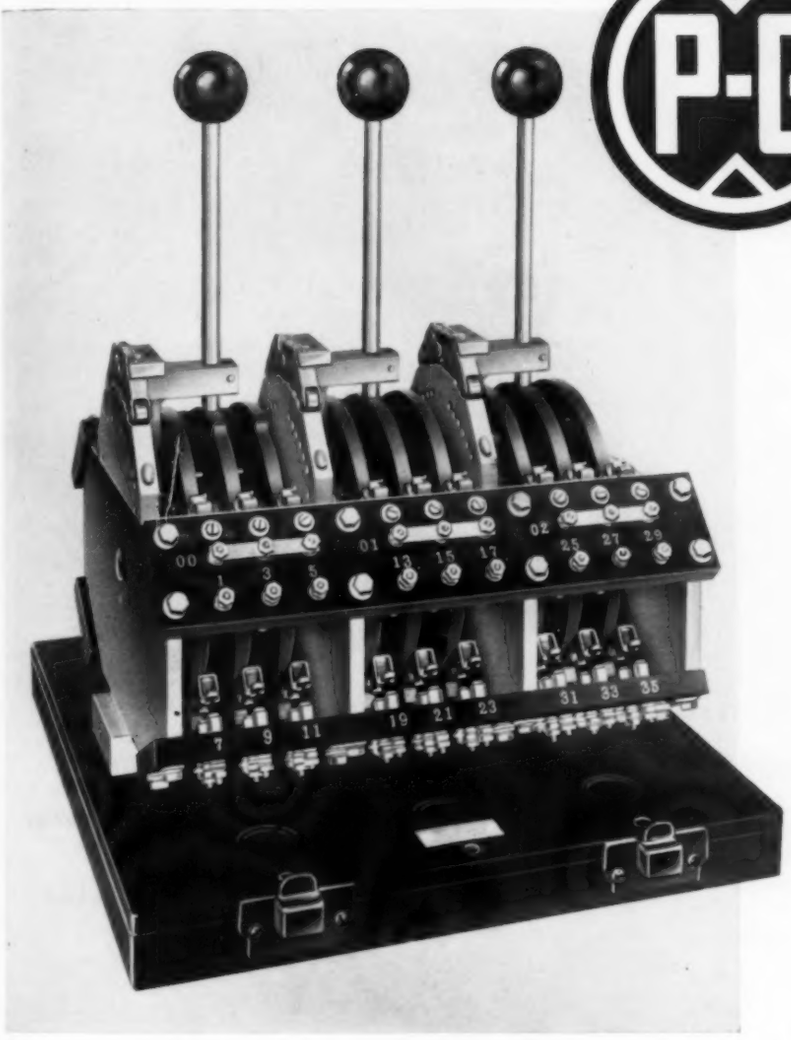
●**GET ALL THE FACTS** about dissociated ammonia, pure, dry hydrogen and nitrogen. **Write today for Bulletin B-52 now on the press.**

DREVER CO.

730 E. VENANGO ST., PHILADELPHIA 34, PA.

Type MD

FOR GENERAL APPLICATION
IN MILL SERVICE



P-G master switches

Unique in design, the Post-Glover Type MD Master Switch saves valuable mounting space in crowded crane cabs or mill pulpits where sufficient room has always been a problem. Up to four single masters can now be furnished in one enclosure on a single base, thereby simplifying installation of the switch.

Each single master has a maximum of 12 circuits and up to 6 points either direction. The operating lever has exceptionally short angular travel and can easily be adjusted in length, thus adding to operator comfort and efficiency.

Write for Bulletin 410—Dept. E

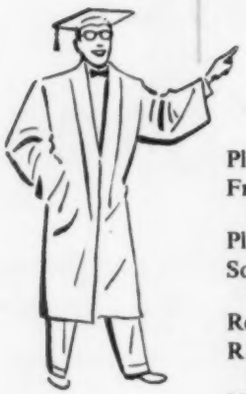
P-G

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

There's Reliable Power Here for Feedwater Pumps *Year after Year!*



Please examine this great E-M Motor
From bearings to coils to heavy-duty rotor.
Plant auxiliaries run hard and long
So driving motors must be extra-strong.
Read the rhymes and you'll see why
RELIABILITY makes *this* motor your best buy!
No tricky formulas you have to see—
Here we have it in 1-2-3!

Why E-M stresses its ability to design large motors for reliability

1 E-M coils hold moisture out
With high insulation strength all about.
With examination you'll be finding
Repeated varnish coats baked on the winding.
It's earned acceptance and admiration,
This E-M "power house" insulation!

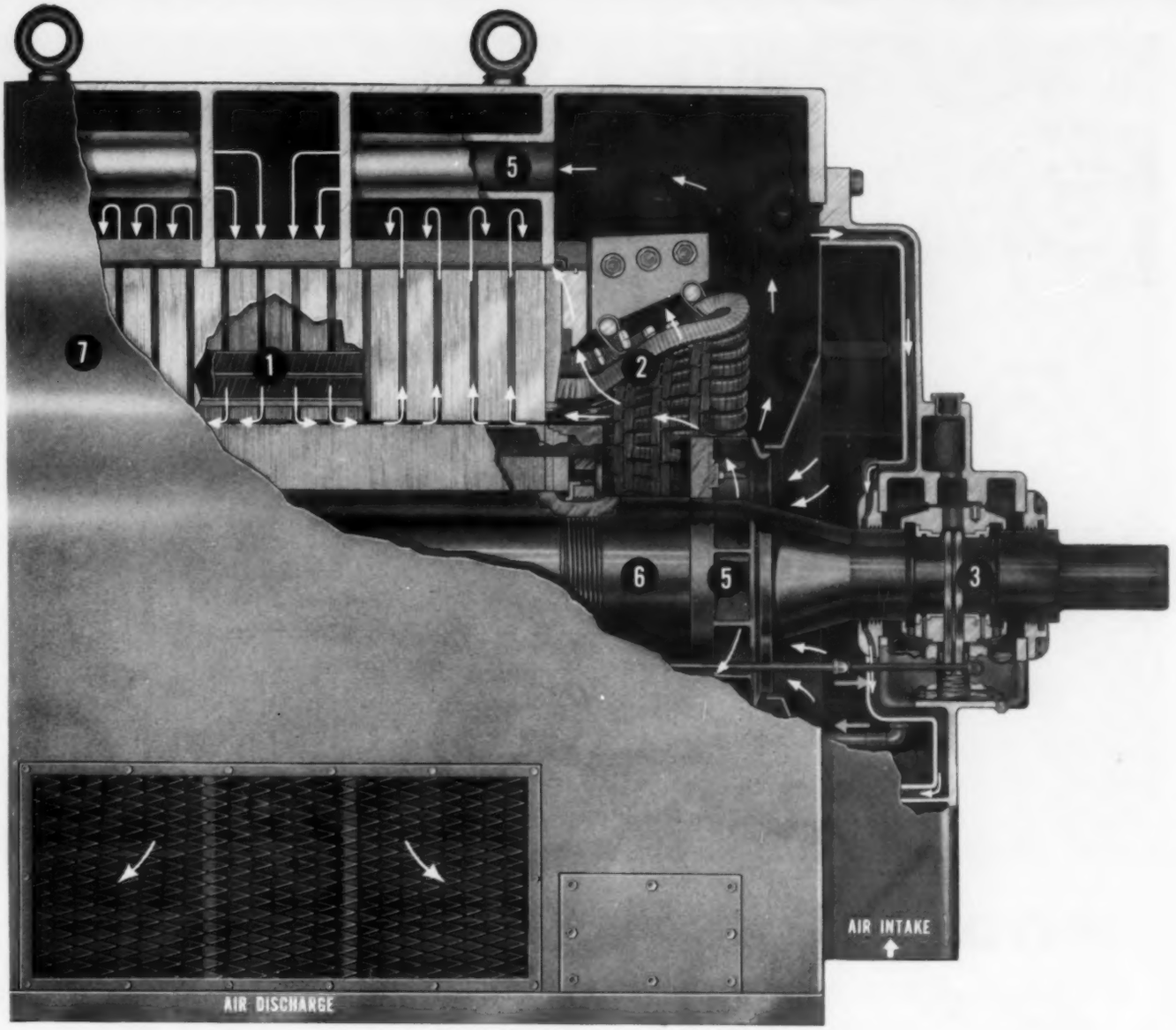
2 You won't find E-M coil-ends in any contortion
Caused by full-voltage starting distortion.
You see, all E-M coils are lashed to each other
And tied to big bracing rings one after another.
You can be sure this E-M coil-end bracing
Is equal to any demand it'll be facing.

3 E-M engineers have had plenty of school
In designing leak-proof bearings that always run cool.
Shaft journals are oscillation-honed so much clearer
Their super finish reflects your face like a mirror.
And the bearing sleeves are centrifugally cast
With strong bond and dense babbitt that last and last.

4 A great deal of your trouble-free operation
Will come from E-M's pressure lubrication.
Take special notice of this choice you are given—
Oil pump can be direct or separately driven.
The oil reservoir gets good ventilation
And it's easy to check the oil circulation.

5 The E-M air distribution is called "Center-flow"
It's uniformly controlled without "big blow".
Aero-dynamically designed blowers have plenty of poise,
Move air efficiently with minimum noise.
You're sure to see, wherever you start,
There's adequate air for each working part.

6 One thing you'll notice about this E-M Motor . . .
Extra-heavy construction of the strong, stiff rotor!
Core laminations have interference fit,
For staying in place, this is really it.
The rotor is balanced with great precision—
A very important smooth-running provision.



E-M 2-Pole Heavy-Duty Squirrel-Cage Induction Motor (1500 HP and larger)

7 One of the most rugged things bearing the E-M name
Is the smoothly-contoured drip-proof frame.
And there's an added noise reduction
In this sleek modern enclosure construction.
It features a "turbine-driven generator" design
When you see it you'll say "This'll be mine!"

These have been some features which you can see—
Large E-M Motors show them tangibly.
Other E-M advantages are behind them, too,
Benefits just as important to you.

For instance, in the field of big motor design
E-M has specialized, straight down the line.
And a broad E-M service organization
Is on "split-second" call across the nation.

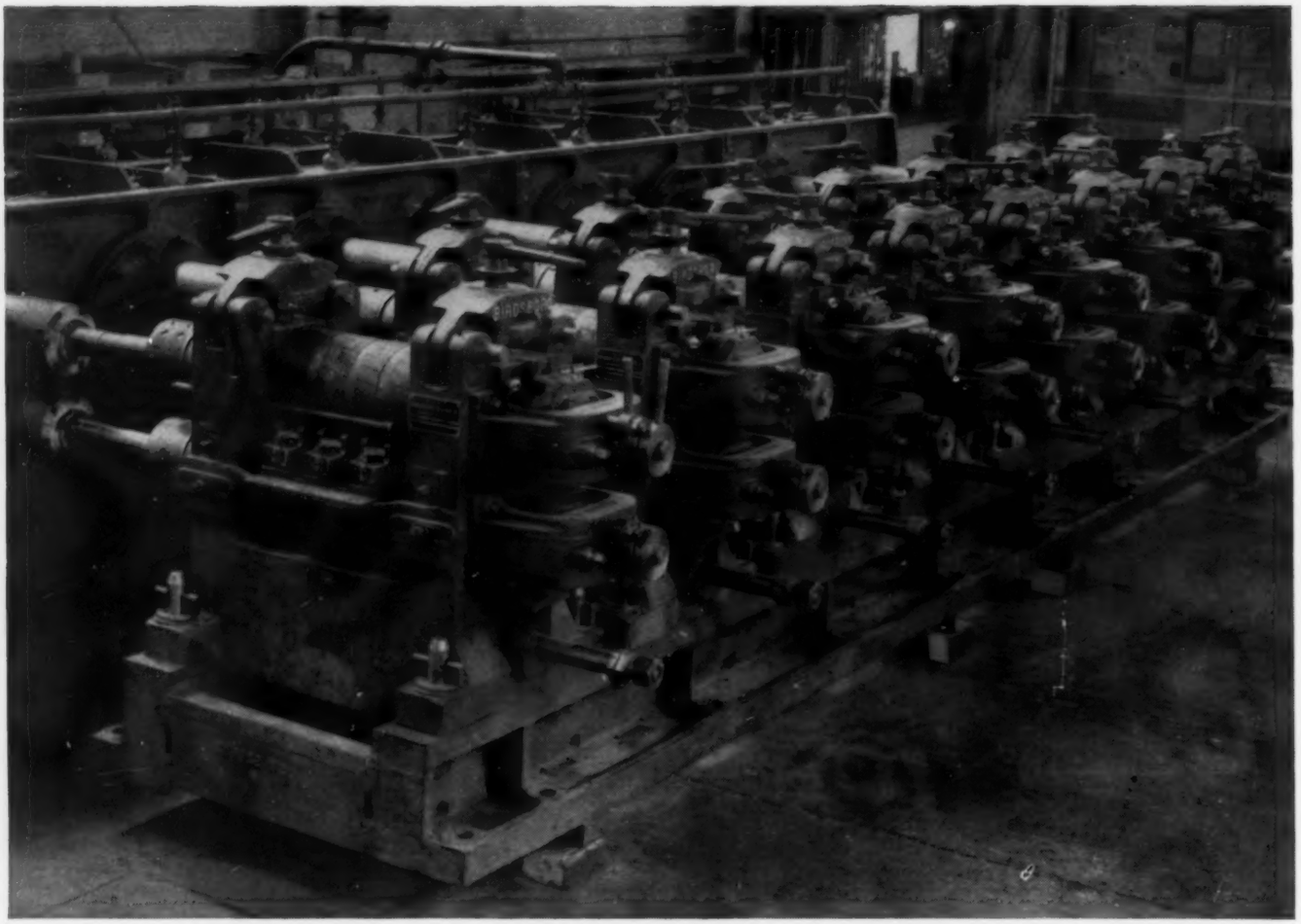
When you specify that big motor... now or next year,
Be sure to call an E-M sales engineer.
And before your plant plans get any bolder,
Write for the new big E-M 2-pole Motor folder!

E-M

1300-TPA-2140

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

SPECIALISTS IN MAKING MOTORS DO EXACTLY WHAT YOU WANT THEM TO



MODERNIZE YOUR ROD MILL

for Increased Production... Lower Costs

Birdsboro's advanced engineering developed a new high speed finishing train, coilers and conveyors to modernize an existing mill. The eight stand finishing train is shown above at shop assembly.

If your production is lagging — or you find operating and maintenance costs are top heavy, call on Birdsboro. We are well equipped and have the engineering skill to modernize existing equipment—or replace it with the most up-to-date, efficient steel mill machinery.

MM-21-51-R

BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. **STEEL MILL MACHINERY** Offices in Birdsboro, Pa. and Pittsburgh, Pa.

•***designers and builders of:*** Steel Mill Machinery • Hydraulic Presses • Crushing Machinery • Rolls • Special Machinery • Steel Castings

Actually see Rust-Oleum applied directly over sound rusted surfaces in your own plant.

Get proof of performance right in your own plant! See Rust-Oleum 769 Damp-Proof Red Primer applied over *your own* rusted metal after simple scraping and wire-brushing to remove rust scale and loose rust. Rust-Oleum's *specially-processed* fish oil vehicle penetrates rust to bare metal—saving time, labor and money.

Rust-Oleum finish coatings in Aluminum, Gray, White, Black, Orange, Blue, Yellow, Green and others provide both *Rust Prevention and Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance and re-modeling. See Sweet's for catalog and nearest Rust-Oleum Industrial Distributor, or clip coupon to your letterhead . . .

There Is Only One Rust-Oleum. It is as Distinctive as Your Own Fingerprint.

RUST-OLEUM®

STOPS RUST!

See Rust-Oleum Demonstrated — Booth 533, Plant Maintenance Show

See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

ATTACH TO YOUR BUSINESS LETTERHEAD AND MAIL TO:
Rust-Oleum Corporation, 2441 Oakton St., Evanston, Ill.

- ☐ Please Show Me the Rust-Oleum "Rusted Panel Demonstration."
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.

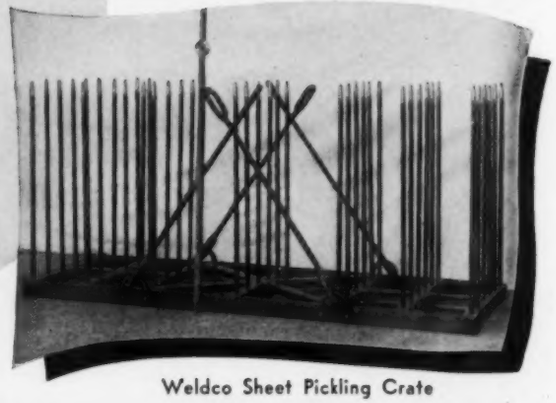
WHAT'S YOUR PICKLING PROBLEM

WELDCO SPECIALISTS HAVE THE ANSWER!

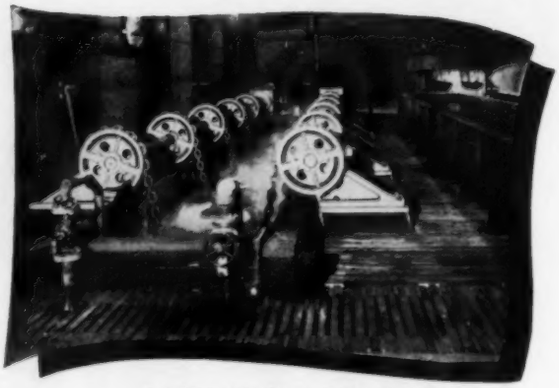
IN HUNDREDS of plants, you'll find Weldco equipment all along the pickling line. For Weldco products are made of corrosion-resisting, hot rolled metals, which withstand attack from hot acids and other pickling solutions. They are strong yet lightweight, wear-resistant, durable, and long-lasting. You get all these advantages when you specify Weldco hooks, mechanical picklers, crates, baskets, racks, chain, steam jets, and accessories.

Weldco offers a complete, well-designed line of pickling equipment . . . plus the services of our experienced staff. Let Weldco engineers take care of all your pickling needs. For any problem, large or small, they have the practical, cost-cutting answer.

Weldco Pickling Hooks

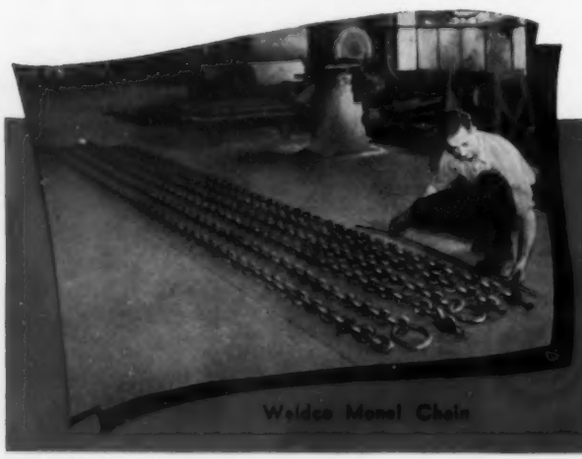


Weldco Sheet Pickling Crate



Weldco Mechanical Bar Pickler

Weldco Mechanical Coil Pickler



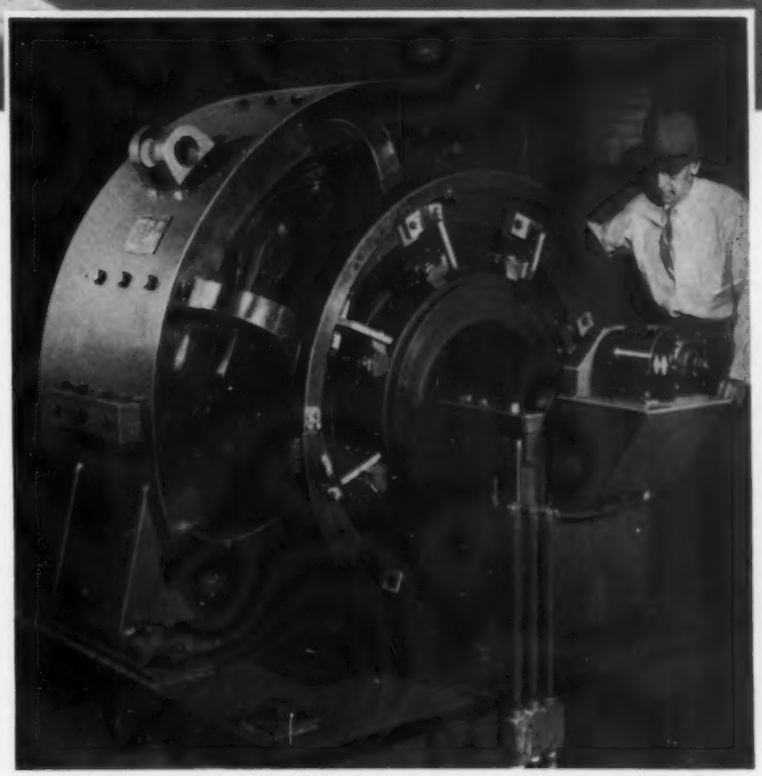
Weldco Monel Chain

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3720 OAKWOOD AVE. · YOUNGSTOWN 9, OHIO

ELLIOTT 1000-hp dc motor helps increase capacity of skelp mill

The two additional mill stands and edging rolls driven by Elliott motors were part of a modernization program which increased the mill capacity approximately 20 per cent. The improvements including installation of the new motors were completed in record time.



This Elliott mill type motor rated at 1000-hp, 400/800 rpm, 600 volts, d-c, powers the production-boosting modernization of a skelp mill. This motor drives the two additional roughing stands made necessary by the use of heavier slabs.

A new edging stand, located after the roughing stands, is powered by an Elliott Crocker-Wheeler 200-hp, 420/1050 rpm, mill type motor.

For details on this and other Elliott large motors, consult your local Elliott representative or write to Elliott Company, Ridgway Division, Ridgway, Pa.

Elliott FABRI-STEEL MOTORS AND GENERATORS R3-27

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL BLOWERS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

RIDGWAY DIVISION

FOR MOTORS 1-200 HP: CROCKER WHEELER DIV. AMPERE, N. J.

Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

SOME interesting year-end statements:

B. F. Fairless, United States Steel Corp.: "U. S. Steel Corp. is backing its confidence in this country's economic future by an investment of approximately $300,000,000 during 1954 in new equipment and replacements of its production facilities."

W. W. Sebald, Armco Steel Corp.: "As an indication of our confidence, at Armco we plan to spend as much for capital improvements in 1954 as we did in 1953 . . . we estimate that the overall demand for steel should reach close to 100,000,000 tons of ingots."

C. M. White, Republic Steel Corp.: "Business could retreat from the high level of the past few years and still be good business . . . The present lull permits us to make much needed repairs and maintenance to mill equipment heretofore too busy to take out of production . . . our economy should continue its steady upward climb."

Admiral Ben Moreell, Jones & Laughlin Steel Corp.: "Replacing old, outmoded equipment is essential to our well-being as a producer of steel . . . our greatest achievements are ahead of us. These will include a continuing program of improvements to existing facilities, the addition of new facilities, the expansion of our markets and the development of new products."

General Brehon Somervell, Koppers Co., Inc.: "Koppers plans to continue during 1954 the program of expansion which it started in 1946. Capital outlay for such expansion will be considerably greater than in 1953 . . ."

Max D. Howell, American Iron & Steel Institute: "There is no indication of a substantial setback in the near future for the steel industry."

Gwilym A. Price, Westinghouse Electric Corp.: ". . . 1954 sales are expected to be the highest in the company's history."

▲

WHEN all the tax adjustments have been made, we'll probably find that never was so little waited for by so many for so long.

▲

THE 80-in. hot strip mill at United States Steel Corp.'s Gary Sheet and Tin Mill has set a new production record of 3,075,244 net tons in 1953. The mill's former record, 2,621,499 tons, was set in 1951.

It is interesting to note that the capacity of this mill, in 1938, was officially set at 716,800 net tons per year.

A correspondent who seems to know us well sends this greeting: "May all your troubles in 1954 be as short-lived as your New Year resolutions."

▲

MANY plants that have tried some form of double roof on their arc furnaces in an effort to eliminate or reduce the dust expelled into the atmosphere have given it up. Many think the best solution is the plan used by Bethlehem Pacific Coast Steel Corp. at their Los Angeles plant. A 30-in. diameter hole is built into the furnace roof and connected by an off take to a "flame trap" where water sprays, automatically controlled by temperature, are installed. The fumes are then led through an electro-static precipitator. An induced draft fan maintains a suction of 0.1 in. water column inside the top of the furnace. Dust recovery runs about 0.75 per cent of the steel tonnage produced.

▲

IN the future, the American Iron and Steel Institute will not report steel production rate as "per cent of capacity," but as per cent of an index figure, 83,837,572 net tons per year, which is the average annual production for the years 1947, 1948 and 1949. On this basis, operations for 1953 would approximate 134 instead of 95.4.

▲

THEY say there are 9,244,000 motor trucks in the United States. They must all drive on the same road we're using.

▲

TOTAL payroll of the steel industry for 1953 is estimated at about $3,300,000,000, more than doubling the 1945 figure and 20 per cent above 1952.

▲

A recent report says that 45 per cent of the engineers in industry are not satisfied with the size of their pay checks. We'll have to get acquainted with the other 55 per cent sometime.

▲

ACCORDING to the American Iron and Steel Institute, steel producing capacity of the United States hit a record high of 124,330,410 net tons per year on January 1, 1954. Blast furnace capacity now stands at 82,001,390 net tons per year, and coke oven capacity at 73,239,540 net tons per year.

▲

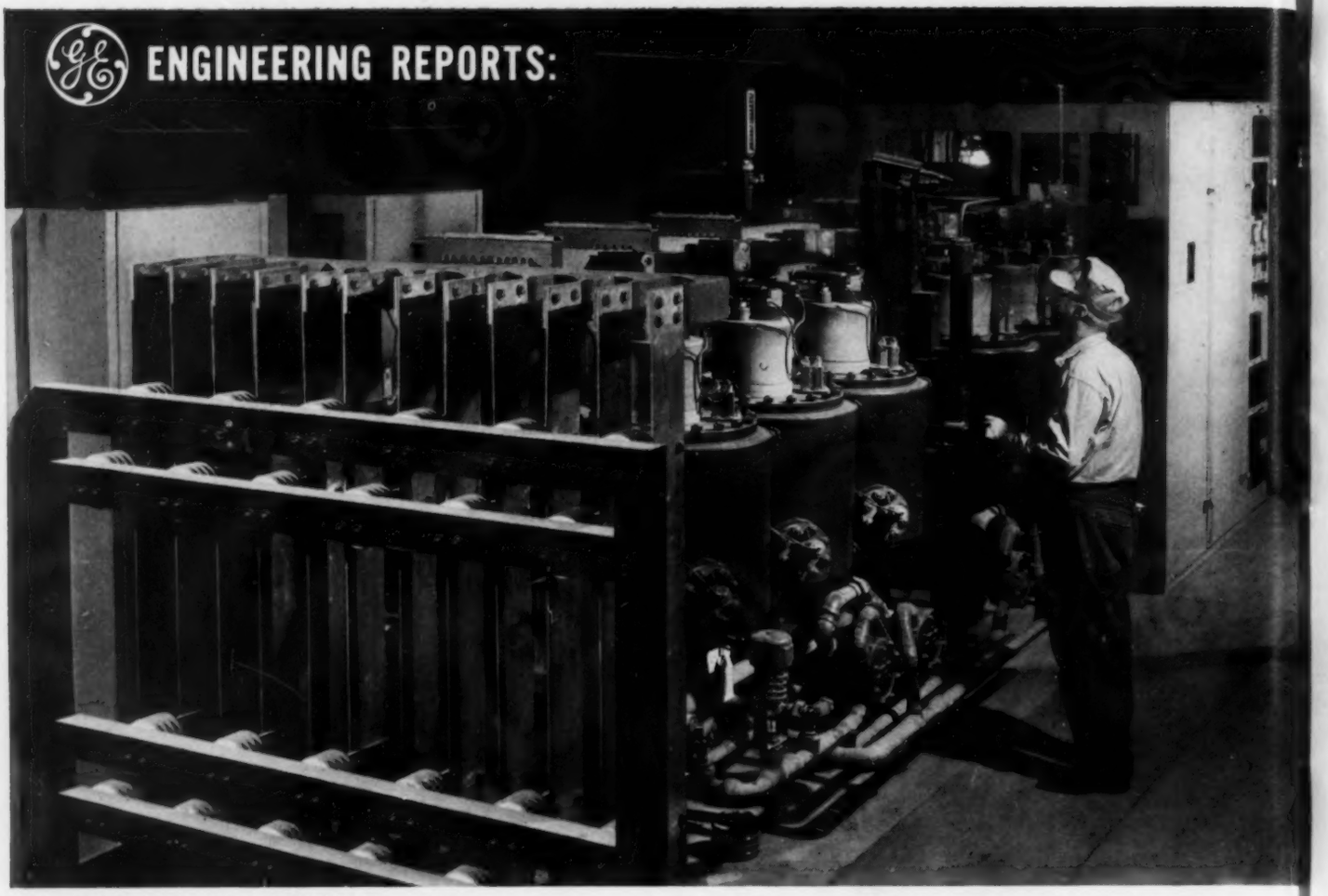
ISN'T it odd that so many Americans who instantly realize that the Russian government can't give its people handouts without first taking them away from the people are nevertheless reluctant to believe that the same condition applies to our own government?

▲

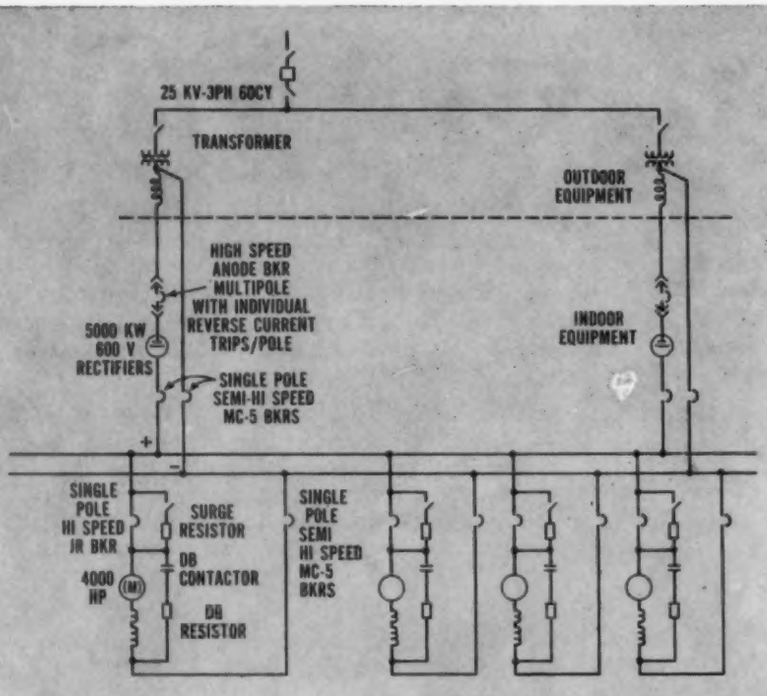
THEY say the best way to get a job done is to give it to a busy man. He'll have his secretary do it.

▲

A man in the next office says that Washington needs all those bureaus they have to store the shirts they're taking off everyone's backs.



FEW INSPECTIONS ARE NEEDED. Here, the motor room attendant checks vacuum of rectifier equipment. Maintenance is reduced because rectifiers have few moving parts. Further, since rectifiers are static, heavy foundations are not needed.



HOW THIS DRIVE WORKS

All motors are connected to a common 600 volt bus, supplied by two 5000-kw rectifiers. The voltage on this bus is held constant during rolling operations by amplistat-type voltage regulators, which combine accuracy and fast response with simplicity, dependability and low maintenance. The amplistat, as well as the rectifier ignition circuit, is completely static—no moving parts.

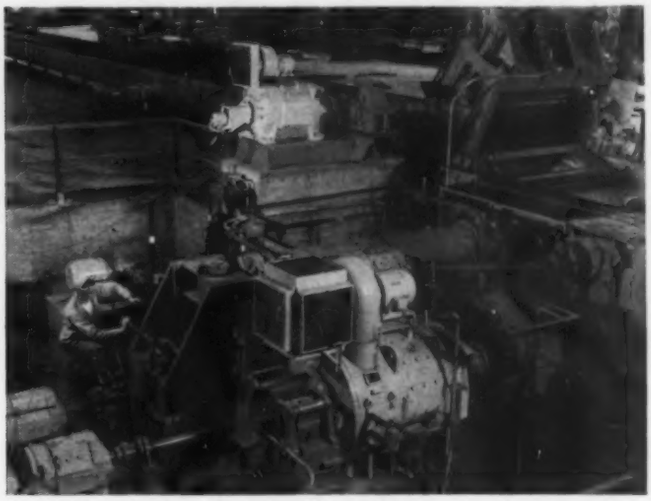
High-speed multipole draw-out type anode breakers are used to interrupt rectifier arc-backs and reclose automatically without interfering with continuity of power supply or voltage regulation. Additional fault current protection and flexibility of operation is provided by rectifier cathode and transformer neutral semi-high speed single pole breakers. High speed breakers with surge cushioning resistors and semi-high speed breakers insure a high degree of protection for the stand motors.

Another example of G-E drive engineering at work!

SLAB THICKNESS IS REDUCED 90% by a 4-high reversing rougher and vertical edger in five to seven passes. Twin 3000-hp motors drive mill; a 600-hp motor powers edger.

INDIVIDUAL RUNOUT-TABLE MOTORS—177 3-hp Type MDY's, specifically designed for this type of service, are part of 2500 horsepower of d-c auxiliary motors supplied.

CO-ORDINATED HIGH-SPEED Type JR and semi-high speed Type MC-5 breakers help safeguard against damage from flashover or overload of finishing train main drive motors.



COILER IS SPEED-MATCHED to last mill stand and runout tables. An improved tension regulator and a separate generator for the pinch roll help improve quality and increase tonnage.

Main drives of Pittsburgh Steel's new mill powered by G-E rectifiers

Part of complete G-E system, these efficient units power finishing train of 66" hot-strip mill

A highly efficient type of conversion system—using two mercury arc rectifiers—has been installed by the Pittsburgh Steel Company to supply d-c power for the finishing train of their new semi-continuous hot-strip mill at Allenport, Pa.

It's the third time rectifiers alone—controlled by magnetic amplifiers—have been used in the United States for such service. Two pumped rectifiers each rated at 5000-kw, convert power from 25,000 volts, 3-phase, 60-cycle a-c to 600 volts d-c. This power drives four G-E 4000-hp finishing stand motors. Strip 66 inches wide can be rolled at a present top speed of 1770 feet per minute.

The Allenport mill's rectifier system was patterned after a G-E "first" which has been in service for more than three years. These rectifiers, like the rest of the power equipment throughout the mill, were selected after careful engineering study. Engineers from Pittsburgh Steel, G.E., and United Engineering & Foundry teamed up to co-ordinate this electric equipment into one smoothly functioning system. These engineers also made provision for future expansion—two more finishing stands and an additional coiler can be easily added whenever needed.

If you are planning to modernize or expand any of your facilities, take a tip from Pittsburgh Steel. Call on G-E steel mill specialists early during the planning stage. General Electric Company, Schenectady 5, N. Y. 659-99

GENERAL ELECTRIC

For More and Wider Copper-Clad Strip at Superior Steel's New Plant...

BLISS TWO-STAND TANDEM MILL DELIVERS THE SPEED (420 FPM) AND ACCURACY (0.0005")

At Superior Steel Corporation's big new Carnegie, Pennsylvania, plant, they're turning out more and wider clad steel strip than ever before. And plant officials cite operating speed as the big reason why.

To speed up the cold rolling end of their line, Bliss converted its two slow-speed single-stand mills into *one* two-stand four-high tandem. Now capable of cold rolling the wider strip at increased delivery speeds from 280 to 420 fpm, the Bliss tandem holds the copper-clad steel within an accuracy range of 0.0005".

Bliss also supplied all new terminal equipment, including tension reels, coil buggy, vertical belt wrapper, entry equipment and other accessories needed to facilitate fast handling.

Superior, like all leading mills in the country, often calls on Bliss rolling mill consultants for solution of mill construction and modernization problems. If you'd like to learn more about the many types of mills we have engineered all over the world, write for a copy of our revised Rolling Mill Brochure.

Remember: BLISS **for Presses, ROLLING MILLS, Special Machinery**

E. W. Bliss Company • General Office: Canton, Ohio

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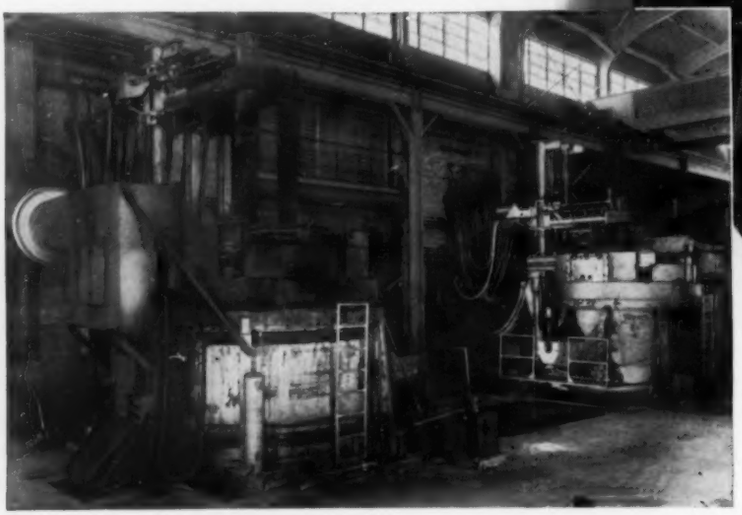

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

APPLICATION AND USE OF SELF-CENTERING ROLLS

By E. T. LORIG
Chief Development Engineer
United States Steel Corp.
Pittsburgh, Pa.

. . . . many ingenious refinements have been developed in the application of self-centering rolls to handling strip . . . .

▲ THREE years have passed since the first commercial automatic self-centering rolls were placed in service and it has been over two years since the paper entitled "Automatic Self-Centering Rolls and Pulleys" was presented before the 1950 Annual Convention AISE at Cleveland, Ohio. (See 1950 Proceedings AISE. p 689).

Many such rolls of various types have been constructed during this period and installed in wide strip processing lines of all kinds where tracking troubles were being encountered. In most such installations immediate improvement in tracking with continuing success was reported. In a few others no apparent improvement was reported as being in evidence. Investigation of the latter indicated insufficient knowledge of the tracking character of materials being processed, including misapplication of the rolls in the processing systems.

This lack of knowledge throughout the strip producing industry is entirely excusable as little published matter exists on the subject to provide a guide toward design placement for securing the desired benefits in effectively tracking flat metal strip which usually is variable in shape as hot rolled or cold reduced.

Shape variances in flat metal strip—both transversely and longitudinally, plus shapes of rolls used—are responsible for most of the tracking troubles encountered in existing lines operating at high speeds which are usually equipped with cylindrical, full-bodied, conventional deflecting and strip actuating rolls—the full length bodies of which extend out beyond the width limits of the strip being processed.

The various types of shape variances in metal strip as received from cold reduction mills in particular, and the types of conventional rolls used are of such vital importance in determining measures to be taken in correcting erratic tracking at high speeds that a resume of the shape variances encountered in both strip and rolls and their effect on tracking should be presented before discussing the reasoning behind the corrective measures which may be taken to secure good tracking.

The phrase "series of full-bodied cylindrical rolls" may be defined as a series of rolls arranged in horizontal alignment and parallelism over which the strip passes contacting the top of each roll in successive order similar to that of a run out table for a hot strip mill. Also as a series of rolls in which each successive roll is arranged in parallelism and alignment at different vertical elevations over which the strip passes in a vertical hairpin-like manner contacting each successive roll in an arcuated condition to change its vertical direction of movement similar to that in a mechanical strip accumulator or in a vertical tower-type annealing furnace. The writer is primarily interested in the latter arrangement as a subject for this paper.

The phrase "good tracking" in the minds of various operators and engineers represents lateral movement of strip on a series of rolls to a variable degree. For some, if all strip passes through a given line without the edges fouling the roll bearing supports or housings, the tracking is considered good. For others, if the strip varies from the roll center pass line in passing even a small fraction of an inch, the tracking is considered poor.

Thus we have two extremes in the phrase "good

tracking"—one leaving practically no tolerance for lateral movement—the other leaving a comparatively wide tolerance varying from zero to several inches in many instances.

To the metal strip producer, some latitude in lateral movement of the strip in process over rolls is tolerated, and if successive strips pass through the line without damage to edges, shape or equipment, the relatively wide degree of lateral movement represents "good tracking."

Unfortunately successive strips charged to lines in coil form are usually not uniform as to transverse and longitudinal shape. Some proceed through short lines at slow speeds very well, while others cannot be processed without encountering extreme difficulties with resulting costly damage and delays.

From the above comments it appears that a suitable definition of the phrase "good tracking" should be formulated for this paper. This definition should be somewhat as follows: The ability of a long processing unit to forward strip after strip constantly at high speeds without detrimental edge guides, regardless of strip contour variances, over a series of suitably designed rolls with little lateral movement under reasonably low strip tensions to avoid localized overstraining of the strip fibres, and secure delivery of quality products without delays or high maintenance costs. A maximum of approximately 2 in. lateral movement in either direction would, to most engineers and operators in the wide light gauge metal strip producing industry, be considered very good and acceptable except at the final delivery or recoiling end of the processing line, where recoiling must be accurate and straight for subsequent operations of the coils as they are unreeled. By high speeds is meant strip speeds of about 400 fpm and greater.

STRIP CONTOUR VARIATIONS AND EFFECTS ON TRACKING

The strip shape or contour variances and their effect on tracking over a series of conventional cylindrical rolls at normal tensions are outlined below: (Note: Normal tensions would be such that no localized fibres in the cold strip would be strained beyond their elastic limit).

1. *Straight flat strip* tends to progressively weave from side to side as the strip proceeds through long lines. High detrimental tensions will reduce the weave, but will not eliminate it entirely without developing over-straining of the edge fibres resulting in edge waves and diagonal welts.
2. *Cambered but flat strip* tends to progressively weave from side to side and progressively diverge off the passline. High detrimental tensions will reduce, but not entirely eliminate, the weave and the divergence, again resulting in waves on one edge mostly accompanied by diagonal welts.
3. *Straight edge waved strip* with the edge and quarter fibres longer than those at the center tracks better than straight flat strip but some weaving will occur. This is for the reason that edge and quarter fibres do not bear hard on the rolls—that the center fibres only are in hard contact at the center pass line.
4. *Cambered edge waved strip* same as above except that progressive lateral movement with some weaving will occur as the strip is forwarded over the rolls.
5. *Center and quarter buckled strip* with the edge fibres shorter than those at the center or quarter positions will invariably track very badly over the rolls. The edges are in hard contact while the center fibres are not. This usually causes excessive rapid lateral movement. High strip tension improves tracking but stretches the edges beyond the elastic limit, usually resulting in permanent edge waves and diagonal welts.
6. *Cambered, center and quarter buckled strip.* Such strip usually cannot be processed properly through long conventional lines satisfactorily. The lateral movement on the rolls is so rapid and extensive that the strip edges foul the bearing housings and supports in short order as the strip is forwarded. High tensions may pull out the short edge fibres on one side resulting in severe permanent strains and diagonal welts.
7. *"Canoe" shaped strip* where the longitudinal fibres increase uniformly in length from both edges to center, but not necessarily at the same rate from either side, resulting in the maximum length fibres being some distance off the center line of the strip. This shape of strip is most difficult to track because of heavy edge contact on the rolls and light center contact somewhat similar to that mentioned in Item 5. High tensions applied to the strip in process will not help matters materially.

FULL-BODIED ROLL VARIATIONS AND EFFECTS ON TRACKING

1. The conditions outlined above in Items 1 to 7, inclusive, become more aggravated from a tracking standpoint as the full-bodied cylindrical rolls become worn. A slight hollowness over the contact area of the rolls will cause greater lateral movement of the strip in passing. This movement is usually persistent in one direction or the other depending upon the contour variances in the strip being processed.
2. Crowning of the rolls, in the ordinary sense of the word (namely, arcing or peaking at the passline), is not good. Strip passing from one such roll to another under normal tensions usually moves at a diagonal—the strip being off center on one roll in a direction opposite to that of the other. This diagonal movement may change from right to left alternately, at times setting up a periodic weaving action at high speeds which cannot be controlled.
3. Rolls under heat in strip heating furnaces subjected to contact with cold strip can cause serious tracking troubles even at relatively low speeds. Cold steel passing over rolls being continuously heated will cool and contract the strip contacting area of the rolls while the heated ends remain expanded. This creates a hollow condition on the

surface causing the strip to move off the passline slowly first in one direction and then in the other with a rhythmic weave that becomes cumulative from roll to roll in the series until the strip temperature is elevated to that existing in the bodies of succeeding rolls where further increase in rhythmic weave tends to cease. This rhythmic weave becomes cumulatively greater as strip speeds are increased ultimately causing the strip edges to contact and cut into the wide walls of the furnace.

4. Heated strip contacting cold roll bodies during cooling of the strip has the reverse effect from that outlined above. The strip contacting area of the rolls becomes heated and expanded while the ends remain comparatively cold and unchanged. This action causes the strip to gradually center itself again as it proceeds over the series of rolls with cold bodies.
5. In long vertical furnaces equipped with a series of full-bodied cylindrical deflector rolls in the heating, holding and cooling zones, it is not unusual to have strip which has been entered on the center passline weave sufficiently in both directions laterally to cut into the brick work on both sides at some position in the furnace and then recenter itself and emerge very close to the center passline.
6. A series of conventional full-bodied rolls that are not maintained in exact parallelism can cause tracking troubles over and above those caused by strip and roll shape variances. Exact parallelism and alignment of rolls of any type in a series cannot be accurately maintained.

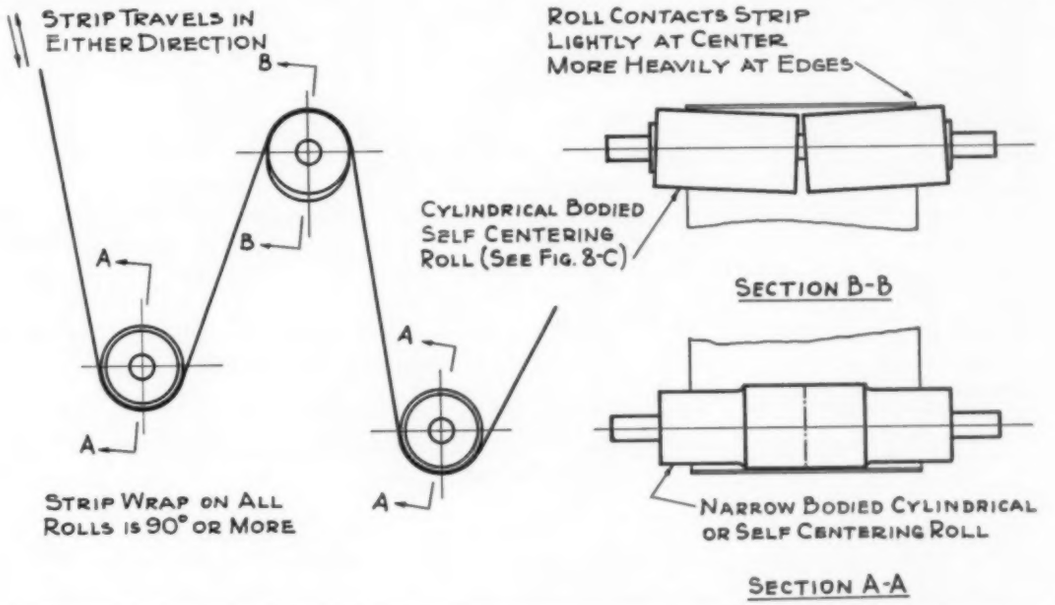


Figure 1 — This assembly is known as the master tracking control roll assembly.

CORRECTIVE MEASURES

Full hard wide cold reduced strip directly from cold reduction mills with all its shape variance is notably difficult to track satisfactorily. If corrective measures can effectively be taken to track such materials through processing lines at high speeds, then they can obviously be effective for practically every line in which tracking troubles are encountered.

Appropriate measures have been and are now being taken to overcome tracking difficulties for strip such as mentioned above and for strip processing lines of all kinds. These measures are based on the use of automatic self-centering rolls of the various types developed, plus changes to the associated full-bodied cylindrical rolls normally used.

The positioning of the various types of automatic self-centering rolls in coordination with the changed cylindrical rolls in processing lines appears to be of major importance in securing the most effective corrective measures possible for strip tracking.

The experimental work done both in the laboratory and on commercial lines now in operation has resulted in what may be termed certain apparent rules to be followed to secure the above mentioned effects. They are fundamentally based on utilizing normally low strip tensions.

For the benefit of those interested, the writer sets forth these apparent rules together with diagrammatic figures which will be referred to as the occasion requires.

Figure 1 shows diagrammatically an arrangement of three specially developed rolls, the assembly of which the writer chooses to refer to as the Master Tracking Control. The rolls need not be close together as shown. In fact, the roll on the approach side of the upper automatic centering roll should preferably be some distance away to provide a fairly long strip lead. The one on the delivery side should be fairly close depending upon the maximum width of strip being processed. The strip wrap around each of the rolls should be 90 degrees or more if at all possible to secure best results.

Some processing lines may require one such master control assembly whereas others may require more.

The writer has found that the roll assembly has the ability to not only center the strip regardless of normal shape variances, but to align the edges closely equidistant from the center passline on the upper roll. Furthermore, the centering and aligning effect on the

strip edges is reflected back a considerable distance from the approach side of the top automatic centering rolls. This effect is also reflected forward a considerable distance from the same point.

The centering and aligning action of the roll assembly may be likened to that of four guide pins arranged in rectangular form a relatively short distance apart, two on each side of a long section of material having lateral stiffness. If one tries to move the stiff material laterally at the extreme ends beyond the position of the pins on either end the diagonally opposed pins will resist such movement.

A mathematical explanation of the centering and aligning ability of the roll assembly in Figure 1 would be somewhat lengthy and complicated and should not be a part of this paper. Suffice it to say that the planar action of the top automatic self-centering roll has the ability to recenter the strip if lateral movement occurs. The lower narrow-bodied cylindrical rolls while having no centering ability in themselves, do have the ability to slightly distort and change the planes in the moving strip properly and sufficiently to cause recentering plus realignment of the edges on all three rolls giving an effect similar to that outlined in the paragraph above.

For short processing lines where the rolls in Figure 1 must be rather close together because of limited space, narrow-bodied self-centering rolls for the two lower rolls may be required to maintain suitable edge alignment.

One rule that should be remembered is that automatic self-centering rolls have the ability to prevent lateral overshooting of the strip because of the opposed lateral frictional forces applied on each side of the center passline. They are, one might say, dampeners of lateral movement or weaving under high strip speeds and low strip tensions. This is not true for narrow-bodied cylindrical rolls where all rotating planes are rectilinear in their action. The combination of both types in a line appear to function properly at any speed of the design placement is correct.

Figure 2 illustrates diagrammatically the centering action of strip passing over narrow-bodied cylindrical rolls moving in parallel legs such as in continuous annealing furnaces, mechanical loopers, etc. The legs can either be vertical or horizontal. Such an arrangement should ordinarily be preceded by the master tracking control shown in Figure 1. Such control may also be required at the delivery end under very high speeds.

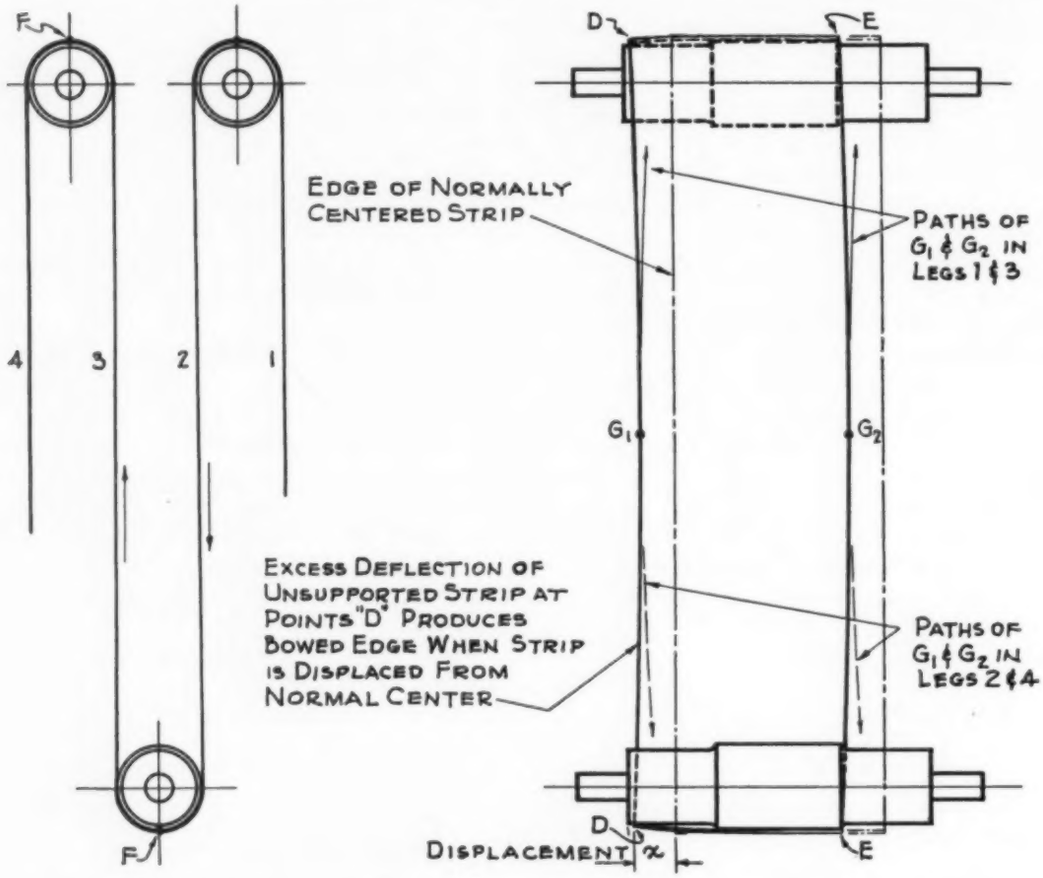


Figure 2—Sketches illustrate centering action of strip moving in parallel legs over narrow bodied rolls.

Here again the narrow-bodied cylindrical rolls have no centering ability in themselves, but they do have the power and ability to change the planes in the passing strip between rolls particularly at the strip edges to effect recentering close to the center passline.

Narrowing the bodies of the cylindrical rolls in the heating section of high speed tower type annealing furnaces, for instance, becomes absolutely necessary for reasons explained heretofore under the section of this paper headed "Full Bodied Roll Variations and Effects on Tracking."

The centering effect of narrow-bodied cylindrical rolls, which incidentally should preferably be used only with low normal tensions, can be explained as follows:

As the strip is moved off the center passline as shown in Figure 2, the weight of the strip and the mean average low tension applied move in the same lateral direction but not to the same extent. This lateral movement

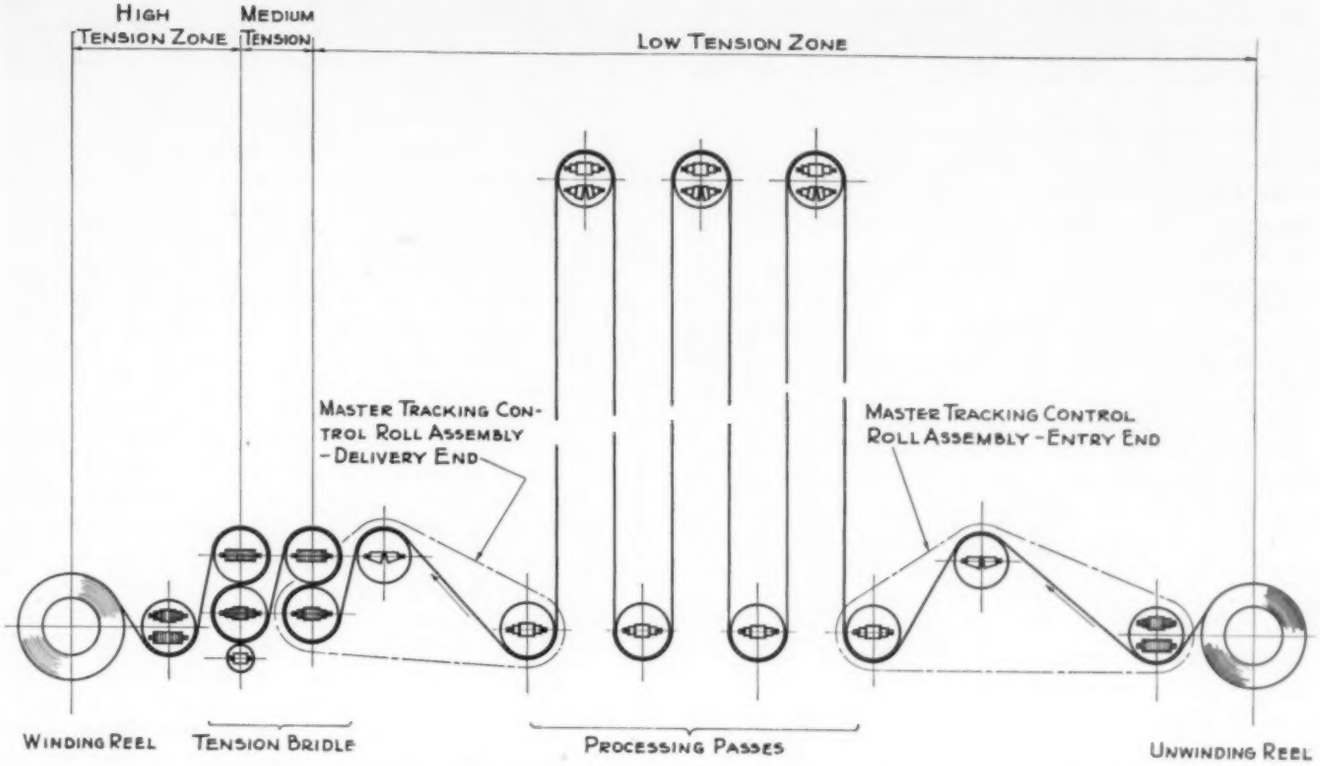
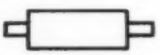


Figure 3 — Diagrammatic roll assembly for a typical strip processing line uses no edge guiding.


FULL BODIED CYLINDRICAL ROLL - FACE WIDTH EXCEEDS MAXIMUM STRIP WIDTH

NARROW BODIED CYLINDRICAL ROLL - EFFECTIVE FACE WIDTH IS LESS THAN MINIMUM STRIP WIDTH

FULL BODIED AUTOMATIC SELF CENTERING ROLL - AS EXEMPLIFIED BY FIGS. 6A, 8A, 8C

NARROW BODIED AUTOMATIC SELF CENTERING ROLL - AS EXEMPLFIED BY FIG 8-B

FULL BODIED FLEXIBLE SURFACED AUTOMATIC SELF CENTERING ROLL AS SHOWN IN FIG. 7

NARROW BODIED FLEXIBLE SURFACED AUTOMATIC SELF CENTERING ROLL AS SHOWN IN FIG. 7

AUTOMATIC SELF CENTERING ROLL WITH GUIDE FLANGES AS SHOWN IN FIG. 6B

NARROW BODIED CYLINDRICAL PINCH ROLL - USED TO INCREASE CONTACT PRESSURE OF STRIP ON DRAG & PULL BRIDLE ROLLS

Figure 3-A — Roll symbols used in the illustrations. Note: All illustrations are diagrammatic, angles and effects are shown greatly exaggerated.

slightly reduces tension in the edge fibres between D-D and simultaneously increases the tension slightly between E-E causing the edge D-G_1-D to bow in a very small amount towards the center pass line whereas the opposite edge bows outwardly from the pass line approximately the same amount. This bowing effect is so

minute in actual practice, when utilizing properly shaped rolls in long vertical legs such as shown in leg 3 of Figure 2 between points F-F, that it does not become visual to the eye.

Nevertheless, the bowing of the edges as shown must exist in the off center position as shown, because of the deflection of points D toward the axes of the spaced apart rolls, while points E have been elevated slightly away from the axes of the rolls.

Since each increment of strip length at its edges must approach the next roll in the series at right angles to its axis of rotation, it follows that the incremental edge lengths such as at points G_1 and G_2 in the moving legs 1 and 3 must move upwardly in the paths indicated by the arrows. Similarly, the incremental edge lengths at points G_1 and G_2 in legs 2 and 4 must move downwardly in the paths indicated by the arrows in dotted lines. Thus each leg will tend to return simultaneously to the center pass line if the series of legs is preceded by a master tracking control roll assembly (Figure 1).

At times, periodic swings from side to side may be encountered in the various legs under high strip speeds. With the master tracking control, Figure 1, located immediately ahead of the series, such swings should be prevented because of the dampening ability of this master control, the effect of which will be transmitted forward through many legs in consecutive order as the strip is forwarded.

Figure 3 shows a diagrammatic arrangement of a series of rolls in what might be termed a simple processing line arranged for good tracking over its entire length.

The arrangement should be typical, the writer feels, of a so-called tight line free of detrimental edge guides for processing light gauges having the greatest possible automatic centering and automatic strip edge aligning ability known to date, based on the knowledge gained not only in the laboratory but in actual practice. See Figure 3-A for symbol illustrations and explanations of rolls designated.

The following important characteristics in the arrangement of rolls should be carefully noted:

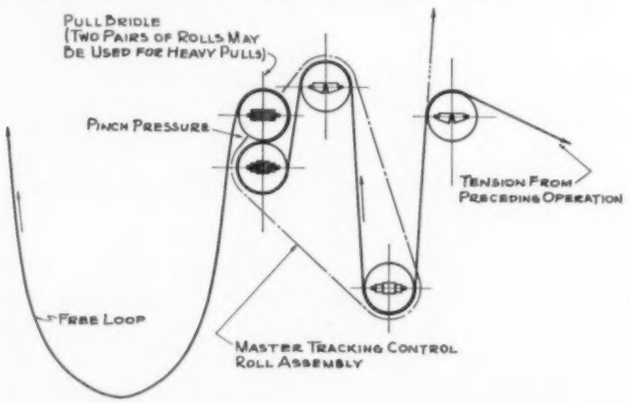


Figure 4 — This roll assembly is recommended for feeding strip into a free hanging loop using no edge guiding.

1. Each roll in the system has a strip wrap of 90 degrees or more. For long lines where long leads exist on the approach side of certain rolls the wrap can be less.
2. The strip passes through the line in a definite pattern—namely, under and over for each successive roll. This has a bearing on good tracking, particularly when forwarding cambered strip with shape variances.
3. A master tracking control arrangement of rolls similar to that shown in Figure 1 is provided at each end of the processing passes. This is advisable for best results.
4. All rolls in the processing passes are either narrow-bodied cylindrical (never crowned or peaked), or if the strip legs are short and numerous, narrow-bodied self-centering rolls may be required in certain places at the top.
5. Three strip tension zones exist—the low tension zone which should extend from the unwinding reel forward as far as possible, the medium tension zone in which the strip tension is increased moderately high, the high tension zone in which the strip tension is increased still further to provide a tightly wound coil.
6. The tension bridle shown essentially consists of four rubber covered wrap around pinch rolls. These rolls are provided with angled slits on the surface to secure an automatic self-centering action. One roll in each set shown is driven to provide pull from the unwinding reel through the processing passes and to provide a drag for recoiling.
7. The line as arranged has the ability to unreel a telescoped or badly wound coil and, if the line is sufficiently long, gradually correct the resulting unwinding lateral movement or weaving effect as each increment of strip length proceeds through the line. The resulting rewound coil tends to be accurately wound and firm. (Note: When each convolution of a coil being rewound is placed accurately on previously made convolutions, the coil builds up firmly and hard under a minimum of tension applied by the tension bridle.)
8. While of little value in existing processing lines, the line shown as arranged in Figure 3 will operate

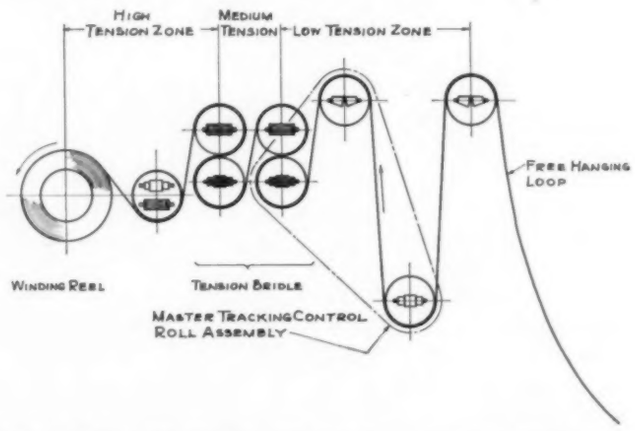


Figure 5 — This roll assembly is recommended for recoiling strip from a free hanging loop using no edge guiding.

in either direction with little movement of the strip off the passline.

9. Rolls in processing lines should, of course, be carefully checked for alignment and parallelism be-

fore operations begin. With the arrangement shown in Figure 3 a slight amount of out-of-parallelism or misalignment caused by variable expansion and contraction or other adverse factors will not disturb good tracking greatly.

The arrangement shown and types of rolls indicated in Figure 3 represent, in the writer's opinion, the best posible design placement of rolls in a simple line for processing flat metal strip having rather bad shape variances. Most high speed lines have looping pits for free hanging loops or mechanical loopers to take up and provide slack at each end. Therefore the line shown in Figure 3 would necessarily be extended on either or both ends to receive such facilities. The design placement of rolls, Figure 3, should, however, be disturbed as little as possible. The suggested arrangements and types of rolls for leading a free hanging loop into and out of a pit are shown in Figure 4 and Figure 5, respectively. In general, the characteristics in the two design placements of rolls shown in Figures 4 and 5, including master tracking, are the same as for Figure 3 except for the changes required to introduce the looping facility on the delivery end.

Mechanical loopers can be introduced in a like manner if required.

BASIC TYPES OF AUTOMATIC SELF-CENTERING ROLLS FOR AUTOMATICALLY TRACKING FLAT STRIP

There are three basic types of automatic self-centering rolls in commercial use today, all three of which, with variations in design only, embody the principles of automatic centering set forth in the writer's paper on the subject presented before the AISE Annual Convention in September, 1950, and published in the November, 1950 issue of the Iron and Steel Engineer.

While the contents of the above paper entered into the need of automatic centering in the steel producing industry during this fast moving age, and into the principles and theories involved based mostly on mathematics and intense laboratory experimentation, yet little was said on the various ways in which the centering principles could be applied to rolls of various types for specific applications in processing lines.

Typical application of automatic self-centering rolls in direct conjunction with narrow-bodied cylindrical rolls for processing lines was discussed earlier in this paper. Therefore, the following statements and explanations in connection with the construction of the three basic rolls mentioned together with reasons for their somewhat unique construction should be considered as supplemental information to that presented in the previous paper mentioned above.

For identification purposes, the writer will allude to the three basic roll as Types I, II, and III in the order named.

Basic Automatic Self-Centering Roll Type I shown diagrammatically in Figure 6-A is the type first constructed in model form and first used in actual practice.

The initial rolls which are idlers were placed in service late in 1949 and are still in daily satisfactory operation conveying and assisting in centering metal strip in a processing line.

This type of roll, which is ordinarily of the idler type, consists of a stationary angled or bent axle on which are mounted two identical rotatable rolls that may be cylindrical, conical or of any other formed shape arranged symmetrical about the transverse center line of the assembly. The roll halves must be arranged for rotation in unison. The large ends of the two cones may be adjacent one another at the center or vice-versa depending upon the end usage and application.

While such rolls may be somewhat more expensive

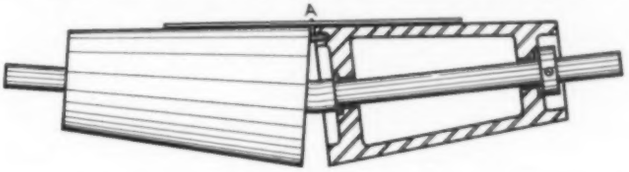


Figure 6-A — Stationary bent shaft automatic self-centering roll.

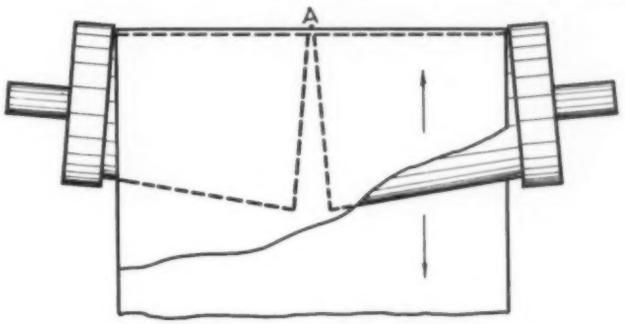


Figure 6-B — Stationary bent shaft automatic self-centering roll with rotating flanges for belt tracking service.

in their construction than other types, yet certain characteristics are present for important applications which cannot be ignored.

The important major characteristics are as follows:

1. The planar action, characterized by the angularity or "toeing-in" effect of the rotating planes in one roll half as compared with the other, can be very little or very great, depending upon the degree of angularity provided in the bent axle. Thus the automatic centering action per running foot of strip passing over can be more rapid than with any other type.
2. Such idlers can readily be dynamically balanced to rotate at extremely high speeds with equally fast automatic centering ability. There is no tendency for the contacting strip to weave laterally or oscillate rapidly at high speeds. In other words, the roll, when utilized properly in conjunction with others, has the ability to quickly dampen out lateral movement, oscillations or fleeting of strip or belts travelling at high linear speeds.
3. The bent axle can be rotated and clamped in any position within limits to increase or decrease the centering speed for a given strip speed as required. This characteristic permits fast centering in one direction only for flat roller conveyor arrangements or for strip in arced contact. The bent axle

can be set for centering materials travelling in either or both directions.

4. The available large angle between rotating planes in one-half of the roll assembly as compared with those in the other half permits recentering even though the roll surface is concave at the closed point A between halves. This concavity or hollowness becomes valuable in many ways. For upside down master tracking control assemblies similar to the right side up arrangement shown in Figure 1 and Figure 6-A, Type I rolls should preferably be used, particularly under low strip tensions, so as to prevent the force of gravity from deflecting the weight of the centering roll in the wrong direction, which action can cause detrimental strip repelling from the center passline instead of the necessary recentering required.
5. With the conical halves having the large ends adjacent one another as shown in Figure 6-A, and with some concavity or hollowness at point A as described above, the roll can be equipped with spaced apart shallow flanges at the roll assembly ends as shown in Figure 6-B. The shallow flanges act as edge guides and will guide cambered strip or belts made from cambered strip with extreme accuracy over such flanged rolls or over the space between two such spaced apart roll assemblies. (Note: Strip always has some camber in either direction—so do belts made from strip whether constructed of metal, fabrics and rubber or any other flat materials).

   It should be noted in Figure 6-B that the strip or belt is funneled between the flanges on the approach and delivery sides, that no edge scraping of the strip edges on the flanges can occur, and that contact between roll body and strip occurs before contact between flanges and strip edges becomes possible. The centering action of the roll delicately balances the strip or belt on the center passline. Therefore, only very light lateral pressures can exist between strip edges and flanges on either or both sides.

   Such flanges are being used in commercial practice today in connection with high speed belt grinders where exactness of belt edge control is vital, and where no fleeting due to camber or other causes can be tolerated. Grinding belts travel up to 6800 fpm and the Type I automatic centering rolls rotate at 10,000 to 12,000 rpm in some instances. Recentering of strip or belts always occurs rapidly in passing over such rotating rolls even though one edge may be riding on top of one flange for a moment or two. The shallow flanges need not be greater in outside diameter or radius than the outer radius of the strip-like passing over the roll in arced contact. Type I rolls with shallow flanges are constructed in a manner such that the outer diameter of the flanges never exceeds the diameter of the roll assembly at the transverse center.

   Together with the recentering planar action of the rolls, the above mentioned provision will cause an off-center strip or belt under normal tension, when used in conjunction with narrow-bodied rolls, to snap to the center passline between the close fitting flanges with a lateral speed that is somewhat astounding. Any attempts to dislodge the strip from the passline once seated between flanges between two such roll assemblies, which are usually spaced apart a few feet at the most, by forcibly warping the strip or belt upwardly and downwardly at either or both edges simultaneously, are apparently futile within the limits of wrecking the strip or belt fibres, of course, which usually are external forces applied far beyond those encountered in actual practice. From the above statements it becomes apparent that, regardless of construction costs, the Type I automatic self-centering rolls lend themselves readily to self-centering in a relatively positive manner for the most difficult automatic recentering applications yet encountered. The mathematics of this development are somewhat lengthy and complicated, and therefore should not be considered a part of this paper. Anyone interested in the mathematics thereof is cordially invited to consult with the author at his convenience.

Basic Automatic Self-Centering Rolls Type II shown diagrammatically in Figure 7 are the second type of automatic self-centering rolls constructed in model form and second to be used in actual practice with good strip tracking results.

Conventional rolls consist of plain cylindrical full-bodied rolls covered with about ¾ to 1-in. thickness of rubber, neoprene, leather, plastics, fabrics or other flexible materials, sometimes crowned or peaked at the transverse center to effect tracking under pressure, and resultant compressibility of the resilient covering at the center passline of the rolls as the strip pressure is applied in passing contact.

The centering action depends upon forcing the fibres at the center passline back at the strip approach and initial contact line a sufficient amount to form a shallow V at the surface of the covering, with its apex on the center passline slightly ahead of this line of contact with the two ends of the V slightly beyond this line.

Rubber, for instance, is incompressible in a confined space when subjected to pressure. Therefore, if a rubber covered roll is crowned at the center and subjected to severe pressure at the approach line of contact with a tight flat strip, the rubber at the crowned center must move backwards—this being the path of least resistance for distortional movement of the rubber. Thus the apex of the V is formed under heavy rubber distortion. This V effect constantly forms under strip pressure and tension applied immediately ahead of the line of roll contact on the approach side, and flattens out again into an approximate straight line as each increment of strip length seats itself in intimate contact on the roll body.

This constant kneading of the rubber at the center passline precariously produces sufficient angled and opposed planar action on each side of the center passline to secure centering of the strip at the approach contact with the distorted rubber. Considerable localized heat is generated at the center passline under high strip tensions resulting in rapid wearing down of the crowning effect originally introduced, accompanied at

times by early disintegration of the rubber covering in the vicinity of the strip passline and at the extreme edges of the strip.

At say 800 to 1000 fpm strip speed, the crowning effect on solid bodied rubber covered rolls wears off or disintegrates rather rapidly. With rubber covered pinch rolls, the pressure between the rolls must be increased periodically to secure stabilization of the strip as rapid wear on the crowns takes place. After less than a week's service, the crowns are so far gone that additional pressure between rolls does no good toward further stabilization of the strip, resulting in fast alternate lateral strip weaving or swings which cannot be corrected without early replacement with properly crowned rubber covered rolls.

frictional effect of the roll surfaces. Radial slots or grooves of any relatively great depth in the rubber covering are not good for strip tracking purposes. According to the experimental work done and as determined in actual practice, the annular rubber rings between such slots or grooves when subjected to radial pressure of the contacting strip under tension will place such rubber rings under compression, causing them to bulge slightly into the spaces left by cutting the slots or grooves. Rubber, or any other similar material free to expand laterally under compression, will not compress in a straight line parallel to the pressure and resistance applied.

For slotted or grooved rubber covered rolls as outlined above, the annular rubber rings will therefore not

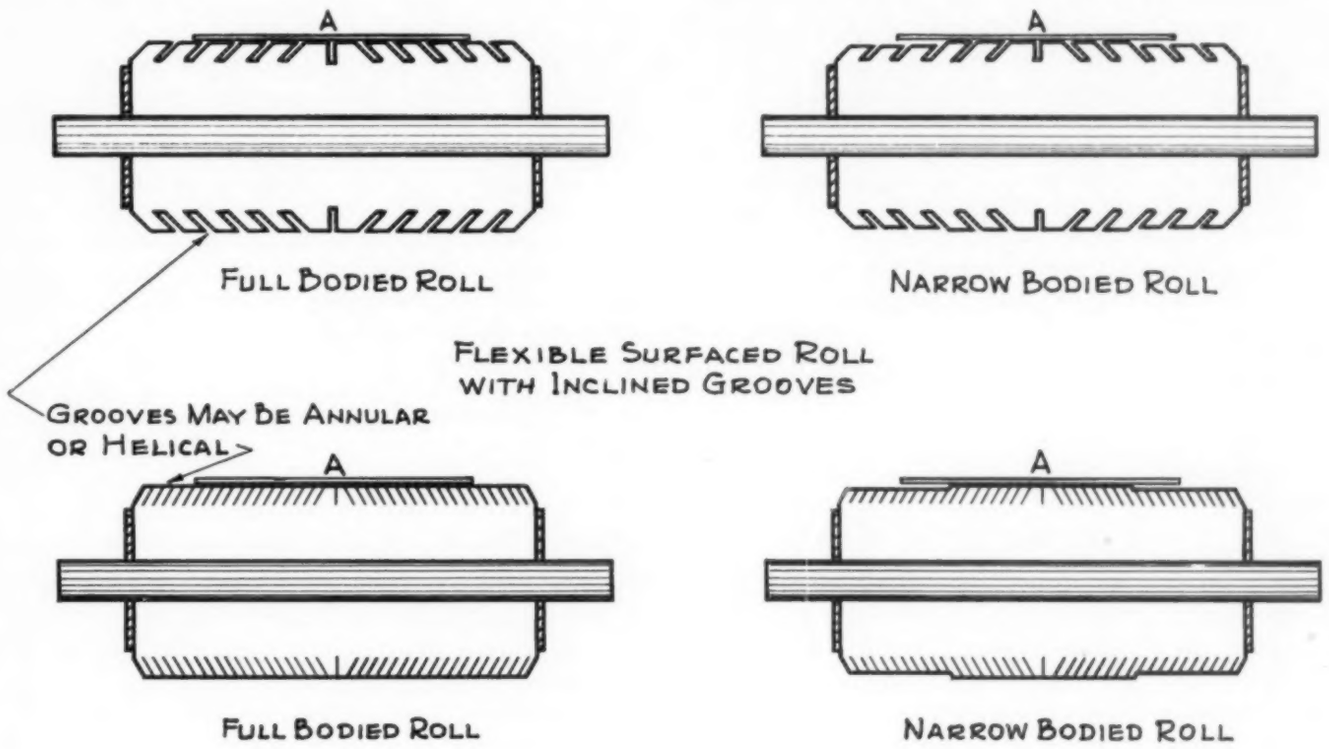


Figure 7 — Sketches illustrate the various kinds of flexible surface automatic self-centering rolls.

Conventional full-bodied rubber covered rolls for forwarding strip have another characteristic that at times causes considerable trouble in tracking metal strip having certain shape variances. If this shape variance is such that most of the strip pressure is on one end of the roll body or the other, the rubber covering will bulge outwardly to a great extent, particularly at the end subjected to the highest pressure. This action changes the normally rectilinear rotating planes at the end of the roll in way of the arced contacting strip in a manner such that "toeing-out" occurs which causes the strip in contact to be repelled rather quickly from the center passline, with resulting strip damage and equipment delays.

At times, conventional full-bodied rubber covered rolls are provided with rather deep annular radial slots or grooves, one or two inches apart, to relieve air film between the roll body and strip thus increasing the compress radially. The diagonal shearing effect induced by compression will tilt the rubber rings causing their outermost surfaces to move laterally in either direction carrying the unrestricted contacting strip with them.

This lateral movement or tilting action starts slightly ahead of the line of strip contact on the approach side of the radially grooved roll. If the strip under tension passes over the roll relatively straight without edge guides, the tilting action of the rubber rings will persist in either one lateral direction or the other. The strip will persist and continue to move laterally in the same direction as the tilt in the rubber rings. If edge guides are used a short distance ahead of the roll, the strip tends to become somewhat crossed in passing over the roll under tension. This crossing action causes the rubber rings to tilt in the opposite lateral direction carrying the strip laterally in the opposite direction also. Thus an oscillating movement or a swing is imparted to

the strip in passing, because of the repelling action of the tilted rubber rings—first in one lateral direction and then the other alternately.

From experimental determinations made by the writer and confirmed in actual practice, the full complement of slots or grooves in rubber covered rolls should never be cut radially to the axis of rotation; the slots, grooves or slits as required should be cut at an angle to the axis of rotation so that the resulting annular rings of rubber can tilt laterally under radial pressure in one direction only, never in both directions alternately which radial cuts invariably permit.

Obviously the full complement of cuts over the full length of the roll body should not be angled in the same direction. Such construction would naturally cause the contacting strip being forwarded to move laterally in one direction constantly, until one strip edge would quickly foul the roll supporting bearings or housings.

The angular cuts should be as shown in Figure 7. The single groove or slit at the transverse center only should be radial (See point A, Figure 7), whereas all others on one side should be inclined downwardly and away from the transverse center. Those on the other side will of course be inclined oppositely.

The single radial groove or slit at the center is very important. If not provided, the truncated cross sectional area produced between the first adjacent inclined grooves or slits cut on each side will react similar to the rings between radial grooves mentioned above when subjected to radial pressure. This cross sectional area will tilt either way under pressure. Because of its greater rigidity, it will be master and cause rapid lateral weaving from side to side.

With this arrangement of cuts, the rubber rings formed between the cuts will always lean in toward the transverse center of the roll as pressure is applied to the roll surface. If the strip is off the center passline on either side, the tendency of the opposed lateral forces released by the inward deflection of the rubber annular rings is to move the center line of the strip back on the center passline of the roll.

The flexible grooved and slit rolls shown in Figure 7 show the construction of the model rolls used for experimental purposes in the laboratory. Such model rolls were constructed with angular grooves approximately $\frac{3}{8}$-in. deep measured radially and at angles varying from 5 to 45 degrees from the vertical. In the laboratory and in actual practice, an angle of about 30 degrees from the vertical seems most appropriate.

In actual practice, the rolls are relatively large in diameter consisting of hollow metal cylinders or solid metal cores covered with rubber and the like in thickness as specified by the user. The thickness of the covering as applied may vary from $\frac{1}{2}$ to $1\frac{1}{2}$-in. depending upon the diameter of the rolls utilized. Nevertheless, grooving or slitting of such rolls as indicated in Figure 7 has the same automatic self-centering effect.

In actual practice, rubber covered rolls grooved in the manner prescribed above utilized with wrap around and pinching effect not only gave the automatic self-centering effect desired, but permitted much lower strip tensions to be used, resulting in increased life from 5 days to 10 or 12 weeks without pressure manipulation between such rolls. In securing the wrap around or "S" effect the grooved roll was crowned or narrow-bodied somewhat while the other roll in contact at the pinch line was cylindrical in nature with no grooves cut in the rubber covering.

With rolls having inclined slits as shown in Figure 7, both of the rolls used to form the "S" wrap with pinch effect between them can be slit in the manner shown which, according to experimentation, improves the automatic self-centering effect somewhat accompanied by still further increase in roll life. The narrow-bodied cylindrical effect on one of the contacting rolls as shown in an exaggerated manner in Figure 7 is of vital importance in securing maximum automatic self-centering or recentering ability in the "S" wrap assembly. This will be explained later.

Basic Automatic Self-Centering Rolls Type III shown diagrammatically in Figure 8-A are the third type of automatic self-centering rolls constructed in model form and third to be used rather extensively in actual practice, because of their simplicity of construction and lower manufacturing cost.

This type of roll with variations in construction, which will be explained later, is up until this time at least being used commercially for satisfactorily tracking metal conveyor belts, short and long wide composition rubber belts, reversing shuttle belts, metal flat strip, etc., under low belt or strip tensions.

Because of the similarity of the Type III roll to conventional full-bodied cylindrical rolls, except that the shell of the former in its simplest form is divided at the transverse center, the writer feels that an explanation of the reasons for lack of centering ability in the one case and good automatic centering ability in the other should be set forth herewith based on experimentation with model rolls of both types, and on commercial practices with full scale rolls of both types.

Conventional full-bodied cylindrical rolls of metal have in themselves no centering or recentering ability whatsoever in forwarding metal strip in contact where the strip has the usual longitudinal and cross sectional shape variances mentioned heretofore. The fundamental reason for this is that practically no or very little deflection occurs in the body of the roll when subjected to either high or low strip pressure. Such rolls are exceptionally rigid transversely in a processing line, except at the journals and bearing supports usually where deflections under load are variable on one side and the other—invariably in the wrong direction to secure recentering under desirable low tensions as explained in the writer's former paper on the subject.

The exceptional rigidity of such roll bodies prevents securing sufficient deflection and resultant differential planar action or "toeing-in" effect of the rotating planes on each side of the transverse center, particularly those planes immediately adjacent this transverse center or center passline which remain rectilinear or parallel in their rotating action. Usually the rotating planes immediately adjacent the transverse center of the roll body are master of the situation so far as strip tracking is concerned, and if in a full-bodied cylindrical roll they remain rectilinear or parallel in their rotating action, which has been proven to be true, then the roll itself has no ability to recenter the strip in contact.

At times a slightly arced crowning effect on the roll body is resorted to similar to that utilized on pulleys for highly resilient non-metallic belts. For flat metal strip arced over a roll body, the safely allowable arced crowning effect can only be 0.0036-in. per foot of body length whereas for highly resilient materials 0.125-in. per foot is utilized to secure relatively good tracking.

Thus the slight crowning effect permissible in full-bodied rolls can have little effect on the ability of such rolls to track flat metals properly. Furthermore, the arced crowning effect does not change the rectilinear or parallel planar action at the transverse center of the roll, which change is so necessary to secure recentering by means of the roll itself. Arced crowning of rolls for forwarding metal strip in contact should never be used, in the writer's opinion, for reasons which will again be discussed later.

It is for this reason that extremely high detrimental strip tensions must be used in processing lines fully equipped with full-bodied conventional rolls. The strip fibres from one edge to the other must be manipulated by highly stressing and straining them alternately to swing the edges on the approach side in the proper direction to secure lateral movement back towards the center passline. This action tends to cause lateral overshooting of the strip, resulting in accumulative strip weaving over a series of such rolls accompanied ultimately by overstraining the edges of strip having certain longitudinal and cross sectional shape variances in the unreeled coils, resulting further in detrimental wavy edges, diagonal welts or ridges and frequently in broken strip.

The Type III automatic self-centering roll shown diagrammatically in Figure 8-A may be considered an exact counterpart of some of the conventional full-bodied cylindrical rolls commented on above, except that the body consisting of a hollow shell has been cut through annularly at the transverse center to separate the two identical halves slightly.

It may be interesting to note that the above procedure has been followed in several instances with good strip centering and tracking results, not only on a model scale basis but for large size monitor experimental processing lines.

The effects of parting the roll body as shown in Figure 8-A can be noted instantly in connection with the recentering and tracking ability of the parted roll. The most important reaction secured is that strip tensions can be lowered to but a fraction of those required with the full-bodied conventional rolls, also resulting in improved centering and tracking ability if the parted roll is used properly in a processing system.

Why do these reactions take place? From Figure 8-A it will be noted that the parted roll has no moving parts. Therefore, whatever reaction occurs must be attributed to the normal resilience and resultant deflections in the various parts of the roll assembly itself. The assembly as noted consists of a rotatable shaft, two spaced apart circular end webs rigidly attached to the shaft and two hollow cylindrical shells each of which is rigidly attached to the outermost diameter of the circular end webs to form what may be termed two identical bells with their open ends closely adjacent one another at the transverse center of the assembly.

All parts of the roll assembly have normal useful resilience, and when the parts are arranged in the design properly, the resulting deflections in each part become coordinated and additive when subjected to pressure on the roll surface. With the ends of the rotating shaft supported in bearings and the load applied to both shells between bearings, the following reactions occur:

1. The shaft deflects slightly in the center and in a direction away from the load applied because of its inherent resilience.
2. This causes the end webs to tilt inwardly slightly toward the load applied.
3. Because of the load applied, the inherent resilience in the end webs themselves causes additional deflection of these webs inwardly toward the load applied over and above that existing because of the tilting action mentioned in Item 2 above.
4. The open ends of the shells adjacent one another at the transverse center of the assembly, because of their inherent resilience and cantilever support, permit slight deflection of the shells themselves inwardly under the load applied which deflection is again in the proper direction and additive to those outlined in Items 1, 2 and 3 above.
5. All of the deflections outlined above taken in total cause the shell on one side of the transverse center line of the roll assembly to rotate out of parallelism with the other when under load. The force of gravity alone is sufficient to cause rotation of each shell out of parallelism as mentioned above.

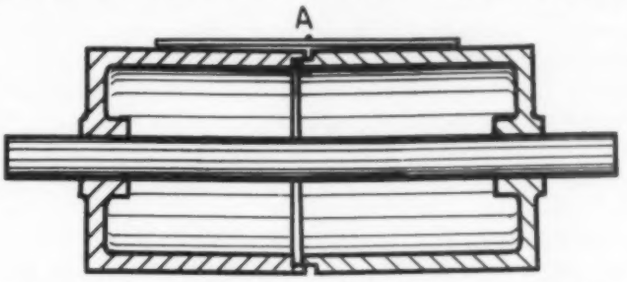


Figure 8-A — Full bodied, rotating shaft, deflection type self centering roll.

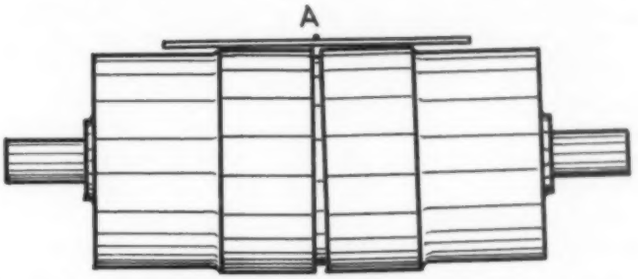


Figure 8-B — Narrow bodied, rotating shaft, deflection type, self centering roll.

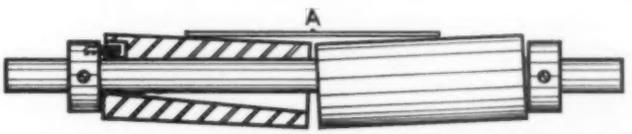


Figure 8-C — Snubber type, rotating shaft, self centering roll.

Thus it becomes obvious that with the roll construction shown in Figure 8-A, the two shells must rotate slightly out of parallelism at all times whether a live load is applied or not. For very low strip tensions, the Type III automatic self-centering rolls should preferably be utilized with the strip passing in contact over the top to utilize the force of gravity and the resultant deflections and "toeing-in" effect of the rotating planes to the best possible advantage.

It becomes obvious further from the cumulative deflections outlined above in Items 1 to 5, inclusive, that the greatest "toeing-in" effect of the planes or the greatest angle of approach between roll halves occurs immediately adjacent the transverse center of the roll assembly and the center pass line of a processing line.

This provision is of vital importance since the area of strip contact immediately adjacent the pass line on each side represents the master control area for automatic centering and tracking over Type III rolls shown in Figure 8-A.

Figure 8-B shows a narrow-bodied Type III roll secured by slightly undercutting each end of the full bodied assembly shown in Figure 8-A. The cylindrical narrow-bodied effect reacts on strip in contact in the same manner shown in Figure 2 and explained elsewhere in this paper. The recentering and realigning ability is fast with little lateral movement of the passing strip. The dampening effect when used in conjunction with conventional narrow-bodied rolls is good, preventing lateral swings in high speed lines.

Figure 8-C diagrammatically shows a Type III automatic self-centering roll for relatively slow strip or belt speeds. Such rolls of the so-called snubber type are in commercial use in close conjunction with other conventional or self-centering rolls. They have the ability to increase or decrease the tension slightly at one edge or the other alternately as a slight lateral movement occurs, thus causing the following roll located closely adjacent on the delivery side (which roll should preferably be narrow-bodied) to tilt the strip edges automatically in the proper direction to secure recentering and realignment of the strip or belt.

The recentering and realigning action is similar to that described elsewhere in this paper for the master tracking control roll assembly shown diagrammatically in Figure 1.

This Type III roll which has centering ability itself because of its angled planar action can be designed in various ways without deviating from its proper functioning for the purpose intended. It is usually utilized as a long bodied roll as shown in Figure 8-C in conjunction with other rolls or pulleys as mentioned above. Shuttle belts for carrying bulk materials in either direction are usually difficult to track both ways. Snubber rolls, resembling those in Figure 8-C, when installed immediately ahead of the tail pulley in the belt return and immediately ahead of the drive pulley when the belt is reversed, will permit the loaded belt to operate either way without excessive lateral movement and damage to its edges.

Such rolls are also being utilized for the purpose of guiding flat metal strip out of looping pits under relatively slow speeds, thus preventing excessive edge damage formerly encountered with stationary or rotary disc edge guides associated with full-bodied cylindrical deflector rolls.

It should be recognized that if automatic self-centering rolls are used to deflect free hanging loops of strip out of looping pits, that little edge pressure on the approach side is required to maintain the strip on the center pass line of such rolls. The strip in free hanging loops, unless cambered greatly, will cause equal pressures on both halves of the automatic centering roll, thus balancing the opposed lateral frictional forces on the surface which tend to delicately balance the strip in contact on the pass line. It will be found that a fast moving strip can be moved slightly off the center of the roll with the pressure of a lead pencil applied to either edge on the approach side.

Free hanging loops of considerable depth will oscillate laterally at times under high linear speeds, causing some lateral movement of the strip in either direction to occur in the arced section passing over the surface of the rotating deflector roll leading the strip from the pit.

If the edge guide rollers, preferably of the grooved type entraining the strip edges, are provided several feet below the deflector roll on the approach side and the deflector roll is of the automatic centering type, then the lateral oscillations mentioned above will tend to be dampened out. Furthermore, with this arrangement the lateral strip edge pressures in the guide roll grooves is so little that no damage to the strip edges will occur. The action of these roller guides is the same as that explained above under Type I automatic self-centering rolls equipped with shallow flanges at each end as shown in Figure 6-B.

To secure better tracking it has been determined experimentally and in actual practice that conventional full-bodied cylindrical rolls without shape should preferably not be used except on rare occasions. This includes both metal and compressible surfaced rolls such as rubber covered rolls.

It has further been determined in actual practice that such rolls should preferably be narrow-bodied and cylindrical over the load bearing area (not crowned or peaked when in service). The narrow-bodied effect should preferably not be less than 16-in. for strip 24-in. and wider—say out to 36 or 38-in.

"Narrow-bodied effect" does not mean that the outer diameter of the roll over the narrow section at the center is appreciably greater than that of the ends of the roll cut down in diameter. Each 0.001-in. differential in diameter improves tracking. For annealed tin plate being processed under 200 to 400 lb total tension at 1000 fpm, 0.020-in. differential with a taper 8-in. long between the differential diameters is excellent and causes no marking of the strip at temperatures of 1100 F or better. For full hard tin plate directly off cold mills, differential diameters of approximately 0.250-in. are preferable to compensate adequately for cross sectional shape variances. For coated annealed tin plate, there is no criterion to follow as yet. A differential diameter of about 0.010-in. properly shaped at the ends should, in the writer's opinion, be satisfactory.

Theoretically at least and as indicated in actual practice, the edges of fast moving wide metal strip should never be permitted to contact roll bodies if at all possible. Hard strip edge contact and light center contact

on full-bodied cylindrical rolls, which condition invariably exists too often because of both longitudinal and cross sectional shape variances, invariably causes lateral movement at speeds which are astounding at times. Hence the necessity for the narrow-bodied rolls.

Narrow-bodied rolls as outlined above when utilized in conjunction with the various types of automatic self-centering rolls explained earlier in this paper, and as illustrated in the various figures on roll arrangements presented, increase the centering, recentering and realigning ability greatly. Narrow-bodied cylindrical rolls in themselves have no automatic centering or dampening ability as explained heretofore. Therefore rather sharp fast lateral weaving or swings under high strip speeds can occur at times, particularly under reasonable strip tensions. Automatic self-centering rolls, of the three basic types commented on previously, have dampening-out ability of such lateral weaving and swings under low and comparatively high tensions when properly designed, constructed and applied.

For economic reasons there has been a tendency over the past few years to increase the speeds and lengths of processing lines. This tendency is increasing rapidly in practically all industries with the added tendency of combining processing functions in one line rather than in several to effect further operating economies.

It is not generally understood that the degree of weaving or lateral movement in either direction of metal strip passing through processing lines equipped with conventional cylindrical rolls is somewhat proportional to several factors other than the strip shape variances mentioned earlier in this paper. These factors are as follows:

1. Increasing the strip speeds in lines increases lateral weaving and progressive lateral divergence of the strip from the pass line somewhat proportionately whether the strip tensions be consistently high or low.
2. An increasing amount of unreeled strip in any such line from one end to the other also progressively increases total weave and total lateral strip divergence from the pass line regardless of the strip speeds utilized. For low average tensions, this total weaving action and divergence is much greater than for high tensions.
3. The increasing amount of unreeled strip mentioned in Item 2 above, usually requires additional looping pits for free hanging loops with exit guides to again recenter the strip and reduce accumulating tensions periodically before it proceeds on its way. Such pits are usually very expensive when the additional electrical controls, drag bridles, etc., are included.
4. Increased strip tensions for better tracking purposes have about reached their limit in long high speed lines. Any further increases tend to deflect roll bearing supports and supporting structures adversely resulting in poor tracking accompanied by over-strained and distorted material in process. Hence the need for more and more intermediate drives to assist in forwarding the strip under reasonable tensions.
5. Increased strip processing speeds usually require the extending of each processing function in the line involving the use of more and more strip deflector rolls to compete the entire number of strip processes involved. Each additional deflector roll used and each foot of increase in strip length unreeled, passing through a line so equipped, increases the total lateral divergence of the processed material from the center pass line. If the line were sufficiently long involving a multiplicity of processing functions, each increment of strip length being processed would never reach its ultimate destination in the line without fouling the roll supporting structure.

From the above mentioned pertinent comments it becomes obvious that three methods exist for more or less successfully forwarding metal strip with its shape variances through long high speed lines.

The first method involves the use of intermediate looping pits as outlined in Item 3 above.

The second method involves the use of intermediate looping pits to a lesser degree than outlined above substituting automatic self-centering rolls including narrow-bodied rolls properly here and there in the line in place of conventional full bodied cylindrical rolls.

The third method involves the use of no looping pits whatsoever, substituting tower type mechanical loopers at each end of the line in their place for accumulating or paying out slack strip as required in high speed units. Thus is formed what is referred to as a tight high speed line from end to end entirely free of free hanging loops of comparatively great depth, which invariably cause trouble when processing strip having certain shape variances, both longitudinally and cross sectional-wise. Under high operating speeds, such strip in deep free hanging loops twists and turns astoundingly first one way and then the other way with an action that at times becomes extremely violent.

The violent turning and twisting reactions imparted at times to free hanging catenary loops of flat metal being forwarded through a processing line have certain implications which should be explained at this point. The significance of these implications has, in the writer's opinion, an important bearing on the design and construction of high speed flat metal processing lines of the future. Engineers, designers and operators alike should be made well aware of the implications involved. Therefore, the writer shall set them forth in the simplest manner possible.

The following statements on the matter are based partly on experimental results obtained from tests performed in the laboratory with relatively short model free hanging loops of flat materials in various conditions of flatness operating over model rolls at various linear strip speeds up to 1500 fpm. They are also based partly on observations and study of the performance of deep hanging loops in catenary form of wide light gauge strip in various conditions of flatness being processed in commercial lines at strip speeds up to approximately 1000 fpm.

In the latter case, the strip being processed consisted of hard cold reduced material directly from high speed cold reduction mills having shape variances such that the strip is difficult to track over conventional full-bodied rolls as explained early in this paper.

Most strip coming directly from cold reduction mills will enter and leave the deep loop or catenary in fairly good shape at the speeds mentioned above if the ends of the catenary are supported far enough apart. From the studies made, however, it appears that strip with certain shape variances difficult to track over conventional rolls as discussed early in this paper are also difficult to form into deep catenaries without encountering severe twisting troubles in both the ingoing and outgoing legs.

At times such strip will twist and turn excessively in either direction, as each increment of strip length approaches and enters the lowermost and smallest curved section of the catenary where the strip is virtually uncontrolled in its lateral and twisting movement and under the least amount of applied tension.

This twisting and turning action is fundamentally caused by unrelieved and non-uniform internal stresses and strains resulting in variable distortion in the variable length fibres over the full width of the strip. Each increment of length of such distorted strip, as it leaves the contact and supporting roll at the entry end of the catenary, will immediately start moving laterally and in a tilt with respect to its surfaces either one way or the other. The same is true in reverse as each increment of length approaches the supporting roll at the delivery end. This slight lateral movement and tilt at the beginning can at times become progressively greater as each increment of length approaches the turning point (the point of least tension) in the catenary, and progressively less as the increment approaches the supporting roll at the delivery end. The lateral movement and tilting action can be likened to that of a live snake being held rigidly at both ends in a rather deep catenary effect. The resulting vibrations and twisting action increases from zero at the ends to a maximum at the center, which is again the point of least tension applied because of the weight of the body being suspended in a deep catenary effect.

If the end supports for free hanging loops or catenaries are not sufficiently far apart to create sufficient tension in the strip at the lowermost turn, the progressive lateral movement and tilting action becomes extremely violent at times in strip with shape variances as described above. Such violent action can at times cause twisting or rotation of the narrow loop at the bottom an amount exceeding 180 degrees. If this happens, which occasionally does happen in comparatively short looping pits, then both legs of the catenary wrap themselves around one another and tie themselves into a knot which will not untangle itself.

Under similar conditions of violent lateral movement and twisting, such strip can at times turn inside out at the bottom of the loop for a comparatively short distance resulting in a close coupled helix in the strip at each end of the inside out section. One of the helices will be formed in a right-handed manner and the other in a left-handed manner. They are not capable of untangling themselves in the pit.

Such troubles are aggravating and exasperating to the line operators in particular. Operators never can anticipate whether the strip being entered into the processing line will traverse the deep looping pits in a satisfactory manner or not. If not, there is nothing they can do about it except to stop the line, remove the twists, shorten up the loops considerably and proceed at slow unsatisfactory speeds.

The implications are that if deep looping pits are to be utilized in high speed processing lines, engineers and designers alike should see to it that the pits are sufficiently long between end supporting rolls for the catenaries to provide sufficient strip tensional and flattening out effect at the turn on the bottom to prevent the twisting and entangling action referred to above.

It becomes evident from the above statements that a so-called tight line from end to end is preferable at high speeds if the strip can be guided with reasonable accuracy and low desirable tensions from one end of the line to the other.

This can now be done as outlined previously in this paper by utilizing automatic self-centering rolls in conjunction with associated narrow-bodied rolls—increasing and lowering strip tensions in various positions in the line if necessary for certain functional operations.

From the three methods of processing metal strip at high speeds described above it becomes clear to the writer at least that method three will most probably become predominant in the future—not only in the metal producing industry but in industries producing and utilizing wide flat webs of all kinds, whether they be metals, paper, plastics, rubber and its derivatives, textiles, etc. This has been done experimentally on motorized model units operating at strip speeds of 1500 fpm and better with small model automatic self-centering rolls rotating at about 10,000 rpm.

Recent full scale commercial applications now in actual practice when processing metal strip confirm these experimental results at strip speeds of 1000 fpm and more. It is this confirmation of the experimental results obtained that leads the writer to express an opinion that automatic self-centering rolls when properly applied in conjunction with narrow-bodied cylindrical rolls will permit processing strip at high speeds in a relatively tight processing line, with good automatic tracking and strip aligning ability heretofore commonly unknown to line operators and engineers alike.

In the writer's opinion, there is no other way available at present to secure more consistent automatic self-centering and alignment of strip being processed at moderate tensions and at high speeds than outlined in the paragraphs above. The writer does not contend that any of the methods outlined are a cure-all for all wide strip tracking and aligning troubles being encountered in processing today. Until someone comes forward with a better development, however, the writer must insist that the contents of this paper include the most plausible means of securing the desired automatic self-centering and aligning results at high strip speeds.

The desired results to be secured by improved tracking under reasonably lower strip tensions remain as outlined in Items 1 to 11, inclusive, on Page 5 of the writer's previous paper on the subject presented before the 1950 Annual Convention of the AISE at Cleveland, Ohio.

DISCUSSION

PRESENTED BY

A. R. RYAN, Industrial Heating Dept., General Electric Co., Schenectady, N. Y.

E. T. LORIG, Chief Development Engineer, United States Steel Corp., Pittsburgh, Pa.

A. R. Ryan: The work done on strip tracking has been very interesting, and I wanted to ask Mr. Lorig if he has done any work using the shaped rolls on steel strip that has already reached high temperature? What I am thinking of is this: If you use the shaped roll, do you tend to distort the strip?

E. T. Lorig: No, the strip is not distorted. We have recently changed one of the tower type annealing lines for silicon strip at our Vandergrift plant, and in the furnace there are narrow-bodied rolls throughout its length, the narrowness being about 20 in. for processing strip much wider than that. With the proper shape on the ends of the rolls, there is no indication of marking or creasing even at high temperatures, approaching 1800 F. There is no tendency to mark or distort the overhanging strip edges with properly shaped narrow-bodied rolls. In fact, the reverse is true under high strip temperatures and low tensions for the reason that when you narrow up the roll bodies, you equalize the pressure across the narrow-bodied section far more uniformly than can possibly be done over a wide cylindrical section with the strip edges in contact. To track strip over wide cylindrical rolls, it is necessary to stretch one edge and loosen the other alternately. This is the only means available for tracking metal strip over full-bodied cylindrical rolls. This is one of the reasons that high strip tensions are needed today when utilizing such full-bodied rolls. The resilience in the strip edges must be utilized to manipulate the edge fibers to secure tracking resulting usually in distorted annealed strip, whereas the narrow-bodied roll effect not only improves tracking but improves flatness of delivery over that existing in the strip at the entry end.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, February 22, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Use of Carbon Graphite and Karbate Materials in Steel Mills," by J. F. Revilock, Head of Product and Process Design, Chemical Carbon Sales Dept., National Carbon Div., Union Carbide and Carbon Corp.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, February 9, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Choosing Electrical Equipment for Belt Conveyors," by W. J. Heacock, Electrical Engineer, Link-Belt Corp., Chicago, Ill.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, February 2, 1954 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Economical Roll Reclamation by Submerged Arc Welding," by J. Goldstein, General Foreman, Welding Shop, Inland Steel Co., East Chicago, Ind.

"Productive Electrical and Mechanical Maintenance," by D. R. Siewert, Manager, Chicago Apparatus Service Shops, General Electric Co., Chicago, Ill.

CLEVELAND SECTION

Monday, February 15, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Use and Application of Conveyor Belts in the Steel Industry," by Harold L. Lawson, B. F. Goodrich Co., Akron, Ohio.

University Club, 3813 Euclid Ave., Cleveland, Ohio.

DETROIT SECTION

Thursday, February 11, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Edison Company Night," Detroit Edison Co., Detroit, Mich.

"Application of Control Regulators to Steel Operators," presented by speakers from: Reliance Electric and Engineering Co., General Electric Co., Westinghouse Electric Corp., and Cutler-Hammer, Inc. — Moderator J. A. Shimmin, Vice President Operations, Rotary Electric Steel Corp., Detroit, Mich.

Dinner — Cafeteria, General Office Building
Meeting — Sales Auditorium, Service Building

PHILADELPHIA SECTION

Saturday, February 6, 1954 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Use of High Velocity Burners for Edge Heating Skelp," by G. J. Campbell, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

"Application of Isley Stacks and Tank Checkers to Steel Mill Furnaces," by H. S. Hall, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, February 1, 1954 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Advancements in Automation of Steel Mill Equipment," by James MacGregor, President, York Engineering and Construction Co., Pittsburgh, Pa. and Vice President, York-Gillespie Manufacturing Co., Pittsburgh, Pa.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

YOUNGSTOWN SECTION

Monday, February 22, 1954 — Dinner 6:00 P.M., Meeting 8:00 P.M.

Paper to be announced later.

Mahoning Country Club, Girard, Ohio.

By R. T. LUCAS, Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

USE OF MAGNETIC AMPLIFIERS IN CONTROL CIRCUITS

. . . . magnetic amplifiers do a good job on loop control of pickle lines . . . .

▲ FUNDAMENTALLY this paper is not intended to deal deeply with the technical aspects of the magnetic amplifier. There have been several excellent papers presented and published by the Association of Iron and Steel Engineers both in district and national meetings. "A Self-Saturating Static Magnetic Amplifier for Regulating Circuits" by H. E. Larson and T. Dunnegan, Jr., of General Electric Co. was given before the National Convention and is printed in the 1950 Proceedings of the AISE. A paper entitled "The Magnetic Amplifier, A Versatile Tool" was presented to the 16th Annual Tool Electrification Forum held in Buffalo, N. Y. on April 1 and 2, 1952, by R. W. Moore of the Westinghouse Electric Corp. On October 1, 1952 at the AISE Annual Convention in Cleveland a paper "The Magnetic Amplifier and its Application in the Steel Industry" was presented by W. E. Miller (See May 1953 Iron and Steel Engineer). At the November, 1952, meeting of the AISE Chicago Section, a paper "Magnetic Amplifiers in Control Circuits," was presented by R. W. Moore. (See July 1953 Iron and Steel Engineer.)

There have probably been several more papers presented on this or related subjects besides the ones that I have listed here.

Basically, the term "Magnetic Amplifier" is used to describe a device which consists of saturable core reactors alone or in combination with other circuit elements and which is used as a power amplifier for control purposes. Saturable core reactors have been used by themselves for power control devices about 35 years. They were applied as a variable reactance between a source of a-c voltage and a load.

The power of the load was controlled by a smaller amount of d-c power which varied the reactance by saturating the magnetic core. We are all familiar with the dimming of theater lights which used this principle.

The self-saturating circuit which was developed in 1935 used rectifiers in combination with saturable reactors. The development of selenium and other dry type rectifiers, along with the improvements in core materials, have greatly increased the performance of the magnetic amplifier.

Many circuits have been devised using the magnetic amplifier for such functions as reel tension control, voltage regulation, speed regulation, IR drop compensation, loop control, and many other applications. I understand that the Detroit Steel Co. has an application of the magnetic amplifier on ignitron mercury arc rectifiers for main drives on their hot strip mill.

There are several advantages in the use of magnetic amplifiers:

1. There are no moving parts. Most everyone in the maintenance field would prefer the maintenance of a static piece of equipment to a rotating regulator with its maintenance of commutators, brushes, bearings, etc.
2. They are more reliable than moving devices with the corresponding longer life as experienced with transformers and rectifiers.
3. As compared to electronic amplifiers, magnetic amplifiers require no warm-up time, are shock-proof, and have a lower heat dissipation with greater efficiency.

4. The coupling being inductive provides a simple isolation between the signal and the output.

The first application of the magnetic amplifier to control the height of the catenary in the pickling tanks was installed in the No. 1 66-in. pickling line at the Weirton Steel Co. in October of 1948.

The No. 1 pickler is arranged with four 80-ft tanks, with the No. 1 or entering tank positioned 4 ft-0 in. below the No. 2, 3 and 4 tanks. After the steel has gone through the processor and welder or stitcher, it is fed into the looping pit by No. 2 pinch roll powered by a 125-hp motor. The No. 3 pinch roll, powered by a 60-hp motor, pulls the strip up out of the looping pit and feeds it into the No. 1 pickling tank. The No. 4 pinch roll which has a 75 hp motor located at the No. 4 tank, pulls the steel through the four pickling tanks. It is between these points that the height of the steel off the bottom of the pickling tanks is regulated.

Placed in the brick in the No. 2 pickling tanks are the two magnetic pickup units, one to be used as a spare. They consist of a saturable reactor sealed in a lead cylinder with leads brought out through a 14-ft lead pipe. The whole assembly is wrapped with alternate layers of flamenol and glass which are bonded together by heat. The saturable core is two-legged and has three windings. There is an a-c winding on each leg and a d-c winding enclosing both legs. The core and d-c winding form a long bar magnet with a leakage return path. Any variation of the position of a magnetic material, which in this case is the steel strip, causes a variation in the core saturation and in the output of the a-c coils. This output of the a-c coils is fed to a loop control unit mounted in the pickle line substation.

The loop control unit consists of a constant a-c and d-c power supply, a loop control amplifier, and indicating meters mounted in a steel cabinet on the control panel. The loop control amplifier is a two-stage magnetic amplifier and provides an output ranging from 50 - 600 milliamperes for the field of a rotating regulator. The first stage of amplification is a push-pull amplifier connection with control fields for the position reference, speed control, speed reference and pickup output.

The second stage is the power stage and consists of a saturable reactor with two field windings. The meters on the cabinet indicate input current, output current, balancing current, pickup biasing current and rotating regulator output voltage.

Two tachometer generators are mounted on the No. 3 and No. 4 pinch roll motors. The respective voltages are compared, and the resultant relative speed signal tells the magnetic amplifier whether the strip is moving up or down. When the relative speed signal is zero, the loop height is not changing. When the pickup signal is normal, the amplifier uses the tachometer signal to hold the No. 3 pinch roll speed in synchronism with the No. 4 pinch roll. The pickup unit detects and causes the control to correct any tendency of the loop to drift up or down.

Connected in series with the No. 3 pinch roll is a buck-boost generator rated 10 kw at 45 volts. This generator is equipped with two fields, one a self-excited for stability and the other field is fed from the output of the rotating regulator. A signal from the pickup unit to the magnetic amplifier that the strip is lowering in the tank will cause a bucking voltage to result in the buck-boost generator which reduces the voltage on the No. 3 pinch roll, slowing it down and causing the position of the strip to rise. Conversely, if the signal from the pickup unit to the magnetic amplifier becomes weaker, a boost voltage will result in the buck-boost generator, increasing the voltage on the No. 3 pinch roll motor which increases the speed and causes the position of the steel to lower. The height of the steel in No. 2 and No. 3 66 in. pickle lines at Weirton is controlled by a dancer roll rheostat. It was felt that since the magnetic amplifier was a new tool, a dancer roll was incorporated in the No. 1 line along with the magnetic pickups. A control switch on the panel will transfer the loop control field of the buck-boost generator from the magnetic amplifier to the dancer roll rheostat.

The dancer roll rheostat has three segments to convey the position of the dancer roll to indicating lights mounted both on the entry and delivery end benchboards and at the ends of the pickling tanks. This, at a glance, will tell any of the operators the position of the steel in the tanks. A red light indicates that the steel is riding too high; a green that the steel is too low; and an amber to show that it is staying within the allowable limits. Since on this first installation no indicating lights could be provided, the pickler operators were inclined to distrust this new tool and preferred to run with the control on the dancer roll rheostat. We then used the dancer roll to operate the lights only, controlling the loop with the magnetic amplifier. This gave our electrical people a chance to find out how this new tool would work and also satisfied the operators since they could visually see the strip position by the lights. Our conclusion was that the magnetic amplifier would work on this application.

However, the pickup units imbedded in the pickling tank lining became shorted due to acid getting in the pickup head. On a rebuild of the pickler, they were taken out and sent back to the factory for a study by their engineering department. New units were made up and installed in our line and performed satisfactorily. At the present time our units are out of service due to the lead lead-in cable being damaged at the last reline of the tank. These will be replaced on the next reline.

It is the opinion of our strip steel electrical men that had the initial installation had a vusual means of checking the strip height, this job of selling the operating people on this system of control would have been of little trouble.

It is my understanding that the controls that have been manufactured recently, incorporate some kind of contact making voltmeter which will give a visual indication of strip position.

We believe that this will eliminate the operating department's objections and have asked our supplier to do this on this first installation.

One supplier has sold a number of these installations in the past two years. Their list shows that 21 loop controls have been delivered since our installation with an additional eight on order. In conclusion, we believe that the magnetic amplifier has its place in the electrical control schemes and we have proven to outselves that it will operate satisfactorily on the loop control of a pickle line.

DISCUSSION

PRESENTED BY

F. O. SCHNURE, Electrical Superintendent, Bethlehem steel Co., Sparrows Point, Md.

F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

W. E. MILLER, Manager Steel Mill Section, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

R. T. LUCAS, Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

F. O. Schnure: We certainly appreciate Mr. Lucas' description of their experience at Weirton with the magnetic amplifier. We also have one in the plant on an experimental basis on the reel of a cold sheet mill, where it's performance is matched against that of a rotating regulator.

Since rotating regulators are doing such an excellent job it might be thought unnecessary to supplant or supplement it with the rather new device. However, if new methods were not given a trial, we would still be back in the days when a salt water barrel and a horseshoe made a good starter for a d-c motor.

F. C. Schoen: If you had not installed the dancer roll what protection in the way of spares would you have carried for the magnetic pick-up? You mentioned that you had a couple of magnetic pick-ups out of service, and since we are making an installation using magnetic pick-ups, spare protection is of considerable interest.

W. E. Miller: Mr. Lucas is to be congratulated on his excellent paper describing the magnetic loop control and Weirton Steel Co.'s experience with the first installation of such an equipment. He has described what is probably one of the best known applications of the magnetic amplifier in the steel industry. I think it is worth noting that this is a combination magnetic amplifier-rotating amplifier regulating system.

The magnetic loop control has certainly had the widest possible acceptance. It is my understanding that it has been used on practically every continuous pickling line installed since its introduction. An engineer from one machinery manufacturer recently told me that since the magnetic loop control was introduced, they have not built a pickling line without it. I also noted one machinery manufacturer listing it as one of the features of his pickling line equipment in an Iron and Steel Engineer advertisement.

As Mr. Lucas mentions, I believe that in most cases where magnetic loop controls have been added to existing installations, it has been the practice to retain the old dancer roll rheostat just in case it might be needed. In these cases, there have been a few failures but most of these have resulted because the magnetic pick-up device was installed in a temporary fashion to obtain the advantages of the magnetic loop control, but without making extensive modifications to the tank. Even so, I believe experience has been that over-all maintenance is lower and operation more reliable with the magnetic loop control. However, on new lines, the magnetic loop control has been the only means of regulating the position of the loop. To the best of my knowledge, no alternate means of regulation has been installed, or desired.

It is true, as Mr. Lucas said, the operators do like to look at flashing lights because apparently they feel that the lights give them a more positive indication of the loop than does the needle rolling around the face of the meter. We have just put in a system that will overcome this "operator problem." The loop position meter has contacts which operate relays, and which in turn operate the lights. This installation has been in operation for several months.

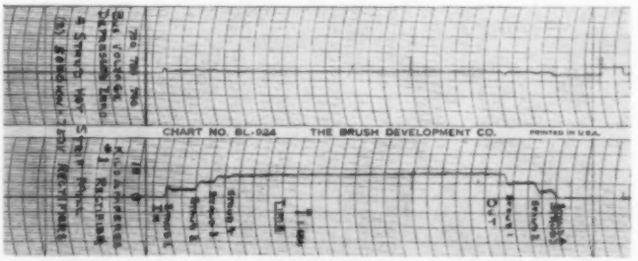


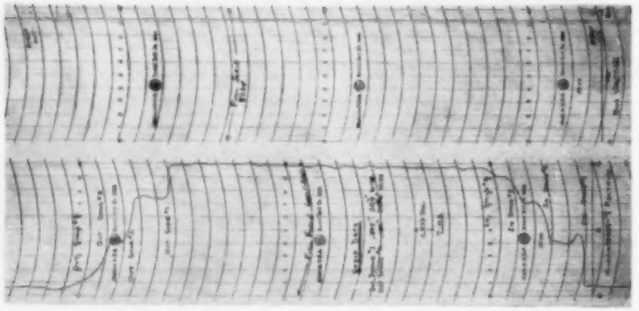
Figure 2 — Transient performance of 5000-kw ignitron mercury arc rectifier using magnetic amplifier type regulating system. Oscillogram of bus voltage was taken using depressed zero to obtain expanded scale.

Mr. Lucas mentioned that the Detroit Steel hot strip finishing mill has ignitron mercury arc rectifiers supplying all the d-c power to the finishing stand motors, and that these rectifiers use magnetic amplifier regulating systems. This is a four-stand mill with two 5000-kw, 750-volt, 6667-ampere rectifiers, and is the second such installation in this country. The transient performance of the equipment is illustrated by the photoelectric recorder and inking oscillograph charts in Figures 1 and 2. The two photoelectric recorder charts were taken one after the other since only one photoelectric recorder was available at the time of the tests. If you look very closely at the voltage chart, you can possibly note a transient drop of approximately 4 volts. There is no perceptible steady state voltage drop.

The charts taken on the inking oscillograph were taken simultaneously. The voltage scale was expanded by depressing the zero by using B batteries. You will note that the maximum transient drop occurred when the strip entered the first stand and is between 3 and 4 volts.

Figure 3 shows the output of the magnetic amplifier which is fed into the phase control circuit of the rectifier.

Figure 1 — Photoelectric recorder charts show transient performance of 5000-kw, 750-volt, 6667-ampere ignitron mercury arc rectifier with magnetic amplifier regulator during rolling of hot strip on finishing mill.



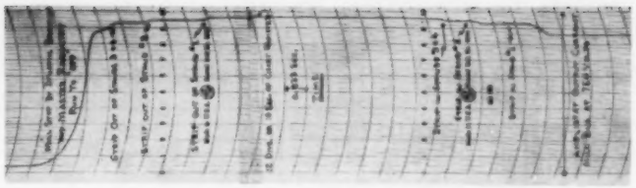


Figure 3 — Photoelectric recorder chart shows magnetic amplifier output signal during transient load conditions on ignitron mercury arc rectifier.

It will be noted that as the strip enters the various stands, the output of the magnetic amplifier increases and reduces the amount of phase control. The mill was stopped at the end of the chart by running the master rheostat to the "off" position. The magnetic amplifier output decreased to substantially zero, phasing the rectifiers off and shutting the mill down.

I believe that the magnetic amplifier has a great future. The magnetic amplifier will probably find the widest application during the next few years, working in conjunction with the rotating regulator and on one-way regulating systems of various types, such as ignitron mercury arc rectifiers, magnetic loop control systems, and for line current control on tension reels.

R. T. Lucas: Had we been putting in a pickling line from scratch, without having any other method of controlling the loop, I do not believe we would have put in anything except the magnetic amplifier.

Normally, I believe that the first installation faulted, or failed, due to the mechanical failure of the pickup units. Since that first failure we have not had a failure of the pick-up unit, itself. The last to fail was due to mechanical damage by people relining the pickling tank. I do not believe we need more than the one spare unit mounted in the tank. However, we should have a couple spare units on hand ready for installation.

I think the fact that they are making this unit now to operate indicating lights is the answer to the method of finding, visually, the positioning of the strips. I think that is one of the most important things in the whole set-up, so the operator can tell at a glance where he is.

For the first time - - -

THE

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AT THE

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FEBRUARY 15, 16, 17, 1954

Make your plans now to attend

Program

ASSOCIATION OF IRON AND STEEL ENGINEERS

WESTERN MEETING

HOTEL STATLER

LOS ANGELES, CALIFORNIA

February 15, 16, 17, 1954

Monday, February 15

8:30 am — REGISTRATION

9:00 am — TECHNICAL SESSION — Sierra Room

Welcoming Remarks by Eric Anderson, President, Association of Iron and Steel Engineers.

Co-Chairmen: Ernest F. Donatic, Assistant General Superintendent, Iron and Steel Div., Kaiser Steel Corp., Fontana, Calif.
Emil Kern, Vice President Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

"The Modern Electric Weld Pipe and Casing Mill," by Norbert C. Rubin, Vice President, Yoder Co., Cleveland, Ohio.

"Control for a Modern Resistance Weld Tube Mill," by Charles E. Smith, Application Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

"Mechanical Extrusion Press for Producing Tubes and Bars," by Astor L. Thurman, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Easton, Pa.

2:00 pm — TECHNICAL SESSION — Sierra Room

Co-Chairmen: R. J. Tremblay, General Superintendent, Bethlehem Pacific Coast Steel Corp., Los Angeles, Calif.
W. A. Marshall, Works Engineer, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

"U. S. Steel in the West," by John L. Young, Vice President — Engineering, United States Steel Corp., Pittsburgh, Pa., and W. F. Pruden, Chief Engineer, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

"The Economics of Replacement in the Steel Industry," by G. G. Beard, President and General Manager, United Engineering and Foundry Co., Pittsburgh, Pa.

"The Electric Furnace West of the Rockies," by W. B. Wallis, President, Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa.

"Helper Drives Help Steel Processing Lines," by E. E. Vonada, Steel Industry Application Engineer, The Reliance Electric & Engineering Co., Cleveland, Ohio.

Tuesday, February 16

9:00 am — TECHNICAL SESSION — Sierra Room

Co-Chairmen: Laurence S. Dahl, Vice President Charge of Operations, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.
William A. Perry, Assistant General Superintendent — Service, Inland Steel Co., E. Chicago, Ind.

"Some Aspects and Trends as Disclosed in Recent Cold Mill Installations," by R. E. Noble, Engineer Rolling Mill Dept., Mesta Machine Co., West Homestead, Pa.

"Tension Regulator on Kaiser Temper Mill," by W. R. Harris, Manager, Industry Engineering Dept. and L. F. Stringer, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Combination Bar and Rod Mill — Los Angeles Plant," by C. C Brandt, Superintendent, Electrical Dept., Bethlehem Pacific Coast Steel Corp., Los Angeles, Calif., and Phillip Scarola, Field Engineer, Elliott Co., Pittsburgh, Pa.

"The Processing and Drawing of Steel Wire," by P. A. Beaman, Manager, Wire Machinery Dept., Morgan Construction Co., Worcester, Mass.

HOTEL RESERVATIONS

Write direct for hotel reservations to Hotel Statler, Los Angeles, Calif., giving time of arrival and type of accommodations desired. Reservations should state that they are for AISE western meeting.

TRANSPORTATION

Individuals or groups desiring assistance in planning their trip should get in touch with the office of American Express Company in their respective cities, or with any local travel agency.

PLANT VISITS

Columbia-Geneva Steel Division of United States Steel Corp., Bethlehem Pacific Coast Steel Corp., and Colorado Fuel and Iron Corp. have kindly granted permission for individuals attending this meeting to visit their plants on the way to or from the meeting.

Arrangements for such visits should be made with the plant involved.

ERNEST F. DONATIC

EMIL KERN

R. J. TREMBLAY

W. A. MARSHALL

2:00 pm — TECHNICAL SESSION — Sierra Room

Co-Chairmen: George B. McMeans, Vice President Charge of Operations, Iron and Steel Div., Kaiser Steel Corp., Fontana, Calif.
John H. Vohr, General Superintendent, United States Steel Corp., Gary, Ind.

"Blast Furnace and Coke Plant Expansion at Fontana," by Clarence R. Lohrey, Assistant General Superintendent, Iron and Steel Div., Kaiser Steel Corp., Fontana, Calif.

"Atomization of Liquid Fuel with High Pressure Gas," by George Grosvenor, Open Hearth Superintendent, Colorado Fuel & Iron Corp., Pueblo, Colo.

"Diversity of Products of Low Individual Tonnages," by W. J. McClung, Vice President, Steel Plant Operations, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif.

"Electric Systems for Main Drives," by W. E. Miller, Manager, Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

7:00 pm — INFORMAL STAG DINNER — Pacific Ball Room

Wednesday, February 17

Inspection Trip to Fontana Works of Kaiser Steel Corp. Buses will leave Hotel Statler at 8:30 am.

LAURENCE S. DAHL

WILLIAM A. PERRY

GEORGE B. McMEANS

JOHN H. VOHR

Abstracts of Technical Papers

To be presented at Technical Sessions of

AISE WESTERN MEETING

HOTEL STATLER

LOS ANGELES, CALIFORNIA

FEBRUARY 15, 16, 17, 1954

"THE MODERN ELECTRIC WELD PIPE AND CASING MILL"

by NORBERT C. RUBIN, Vice President, Yoder Co., Cleveland, Ohio

N. C. RUBIN

▲ THE ordinary sizes of steel pipe and casing have been produced by the electric resistance weld process for a number of years, starting originally in the Youngstown area. Those particular mills have been improved at various times but, obviously, limited to revisions which could be done without major rebuilding.

During the past five years, several new large electric resistance weld pipe mills have been built and put into operation. The most recent of these installations, and the one which we will discuss here, is at the plant of the Lone Star Steel Co. in Texas.

There are two complete tube mills at Lone Star Steel, one of them having capacity from 2 to 6⅝-in. outside diameter, and the other 4½ to 16-in. outside diameter. The smaller mill will accommodate wall thicknesses from 0.125-in. minimum to 0.337-in. maximum. Likewise, the larger mill will handle wall thicknesses from 0.125-in. minimum to 0.557-in. maximum. The small mill will operate at speeds up to 150 fpm and the large mill at speeds up to 120 fpm. Within these ratings, you will find practically all of the popular sizes of pipe and oil country tubing.

Basically, these new mills involve the same processes used in early mills of this type, but many improvements have been brought about which result in higher speeds, yields and efficiencies. Also, both of these mills can make a definite claim of being the very first in existence to:

1. Produce casing from multiple width slit stock.
2. Use coil stock up to 0.375-in. thick.
3. Have a flying automatic rotary cutoff machine for 16-in. pipe.

To describe the mills briefly, both of them are comprised of uncoiler, leveller, side trimmer, roto-blast, forming mill, electric resistance welder, pullout unit, automatic flying cutoff machine and runout table. Immediately following, in each mill, is a rough straightener, normalizing furnace, cold reducing mill, and final rotary straightener. Beyond that are the usual items of finishing equipment.

There are many innovations in the electrical drive and control equipment, as well as the power supply to the welders, but all of this will be dealt with in a separate paper.

"CONTROL FOR A MODERN RESISTANCE WELD TUBE MILL"

by CHARLES E. SMITH, Application Engineer, Cutler-Hammer Inc., Milwaukee, Wis.

C. E. SMITH

▲ THE Lone Star Steel Company at Lone Star, Texas, has recently installed a pipe welding machine for producing continuously welded line pipe and casing from multiple width skelp. This machine produces 15, 30, 45, or 60 foot lengths of pipe ranging from 16 inches to 4.5 inches outside diameter and wall thickness of from 9/16 inches to 3/16 inches. Welding speed is adjustable from 40 to 120 feet per minute. The mill is designed to weld pipe from either coiled skelp or precut plates.

The paper describes the electrical controls furnished for skelp processing, forming, welding, cutoff and siz-

ing machines used in the pipe mill. The greater part of the paper deals with the adjustable voltage d-c mill drives and the weld power controls, with emphasis on the flexibility of operation obtained as well as the methods employed to keep pipe waste at a minimum.

"MECHANICAL EXTRUSION PRESS FOR PRODUCING TUBES AND BARS"

by ASTOR L. THURMAN, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Easton, Pa.

A. L. THURMAN

▲ THE mechanical extrusion press has been economically producing steel tubing for over twenty five years and during this period has extruded all types of steels, including the various grades of stainless and high alloy steels. The press has been used experimentally for the extrusion of aluminum and copper, and has also produced bars and shapes from all of these various materials.

The mechanical extrusion process is based upon a patent issued in 1901 in Germany and in 1903 in England. Recognizing the importance of high extrusion speed for manufacturing steel tubing, R. Bungeroth applied this patent to a mechanical extrusion press which had been invented by F. Singer. A German company manufactured the first mechanical extrusion press for steel tubes and further developed it to its present operating efficiency. Three mechanical extrusion presses are now in continuous operation in Witten, Germany.

The early patent covered the use of fusible slag and other solids like glass as lubricants for the extrusion process. As a result the Witten Works carried out broad experiments with glass and many other lubricants. While glass has been found to be a satisfactory lubricant for steel extrusion in a slower process when glass is given time to melt, it was not found to be at all suitable for the fast cycle of the mechanical press. The most satisfactory lubricant for the mechanical extrusion press has been found to be a mixture of graphite, oil and a separate chemical ingredient.

This paper describes the operation of the press in detail and presents operating schedules for some of the products from the press. The operating cycle, production rates, range of products, tooling, material preparation, power consumption and maintenance are discussed.

"U. S. STEEL IN THE WEST"

by JOHN L. YOUNG, Vice President — Engineering, United States Steel Corp., Pittsburgh, Pa., and W. F. PRUDEN, Chief Engineer, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

▲ THE first part of this joint paper will briefly outline the formation and development of the several divisions of United States Steel, including Columbia-Geneva, Consolidated Western, Oil Well Supply, U. S. Steel Products, and U. S. Steel Supply that serve the western states of the United States.

JOHN L. YOUNG

W. F. PRUDEN

The second part will deal more specifically with the development of the Columbia-Geneva Steel Division that started twenty-four years ago with one blast furnace at Provo, Utah, producing pig iron for the steel plants at Torrance and Pittsburg, California. Later developments included the building of the Geneva Plant in Utah and more recently the construction of modern sheet and tin plate facilities at Pittsburg, California.

"THE ECONOMICS OF REPLACEMENT IN THE STEEL INDUSTRY"

by G. G. BEARD, President and General Manager, United Engineering and Foundry Co., Pittsburgh, Pa.

G. G. BEARD

▲ TECHNOLOGICAL progress and increased production are so vital in a modern economy that various organizations working with business management have recognized the need for the development of a sound replacement policy. This paper introduces to steel plant replacement problems the work of The Machinery and Allied Products Institute on equipment analysis. Replacement problems are beginning to be recognized in their true light and their solution is being attacked on a more logical and scientific basis than heretofore. Such is the basis of the MAPI formula, the application of which to steel plant problems is explained in this paper.

The application of the MAPI formula requires the recognition of the economics of replacement as a whole, and fundamentally that many of our nation's productive facilities are not as up-to-date or efficient as many of us think.

The paper develops the need for a sound replacement policy, the nature of replacement, deficiencies in popular methods of analysis, and finally the development of the MAPI formula.

The application of the formula to two illustrative cases is presented together with a review of various factors to be considered in a replacement analysis.

The paper also includes a brief review of the importance of proper organization for formulating replacement policies, together with brief comments on

the subjects of depreciation and interest rates as they affect replacement analysis.

"THE ELECTRIC FURNACE WEST OF THE ROCKIES"

by W. B. WALLIS, President, Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa.

W. B. WALLIS

▲ THIS paper outlines the progress that has been made in steel production on the West Coast of the United States, laying particular stress upon the production of electric furnace steel. While some papers have been given that covered the situation in general, an attempt here is made to break down the production, first, into the type of steel produced: i.e., open hearth, bessemer or electric furnace, and, secondly, to segregate the steel production into the field of ingots and castings produced by the various types of melting equipments. The period covered is from 1920 through 1953, and shows the progressive growth over those years, making comparison of the rate of growth on the West Coast compared to the United States in general.

Particular stress is laid upon the possibility, in non-integrated plants, of the application of the electric furnace for the production of steel both in ingot and cast form; comments are made as to the future possibilities.

"SOME ASPECTS AND TRENDS AS DISCLOSED IN RECENT COLD MILL INSTALLATIONS"

by R. E. NOBLE, Engineer Rolling Mill Dept., Mesta Machine Co., West Homestead, Pa.

R. E. NOBLE

▲ THIS paper discusses recent trends in the cold rolling of flat steel products. Rolling speeds, power and coil weights have increased gradually from the very beginning of the history of the continuous rolling of strip and sheet steel products in backed up mills. Within approximately the past seven or eight years, however, there have been rather spectacular developments in this direction, especially in the rolling of tin plate gauges, with resulting important changes in a number of the details of the mill equipment. This has been especially true with respect to coil handling equipment at both entry and delivery ends of the mill, and other auxiliary mill features such as roll and strip cooling, lubrication, gauging, tension control and measurement, etc.

The general aspect of the main mill drives has also changed. Early low speed mills required double reduction gear drives between motors and rolls. Recent high speed mills of all categories have either been driven directly from the motors without speed change, or in the case of the highest speeds have employed speed up drives (usually with individual motor drive to each roll) on account of motor limitations with respect to the combination of increased speed with increased power.

This discussion is limited, however, to the purely mechanical features and problems of the mills proper and their immediate auxiliaries. There is no consideration of strictly electrical features (without which these developments would have been impossible) or of such important adjuncts of the cold mill plant as pickling, cleaning or shearing lines. The major emphasis of the paper is on tandem reduction mills (especially tin plate mills) and their layout and design features, including their essential auxiliaries, but there is also a brief description of a typical reversing stand and some mention of skin pass or temper mills.

Arrangement of mills and auxiliary services are treated with respect to the overall layouts and several typical recent mills with their auxiliaries are described in part. These include two mills on the Pacific Coast as well as recent mills in the Eastern part of the United with one or two examples of foreign mills.

Some of the problems posed by the trend to higher speeds are treated as they affect specific details of the power train such as bearings and driving spindles. The paper concludes with a brief evaluation of recent progress and a discussion of continuing problems in their relationship to present trends.

"TENSION REGULATOR ON KAISER TEMPER MILL"

by W. R. HARRIS, Manager, Industry Engineering Dept. and L. F. STRINGER, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

W. R. HARRIS

▲ THE 4000 fpm, four-high, two-high, two-stand temper pass Mill at the Fontana, California Works of the Kaiser Steel Corp. has been equipped with a magnetic amplifier feedback control system for regulating strip tension between stands. This regulator employs a two-stage, two-channel magnetic amplifier which excites the field of the booster generator in series with the motor armature driving Stand No. 1, and a small deflection, variable reluctance type tensiometer for tension measurement.

The mill drive is described briefly before presenting a detailed description of the tensionmeter and the associated tension regulating system. Certain considerations involved in the design of the system and the

results of a system study made on an electronic analog computer and on which the system design was based is discussed.

The actual performance of the system is described by presenting brush oscillographs taken during normal mill operation and when step changes were made in the tension setting.

L. F. STRINGER

This regulator has been in service for nearly a year now and has proven to be highly successful. The ease and speed with which changes in the tension setting can be made and the close regulation of strip tension provided during acceleration and deceleration of the mill has made this type of tensiometer of indispensable value to the mill operator from an operating viewpoint as well as from a consideration of product quality.

"COMBINATION BAR AND ROD MILL — LOS ANGELES PLANT"

by C. C. BRANDT, Superintendent, Electrical Dept., Bethlehem Pacific Coast Steel Corp., Los Angeles, Calif., and PHILLIP SCAROLA, Field Engineer, Elliott Co., Pittsburgh, Pa.

▲ BETHLEHEM Pacific's steelmaking and fabricating facilities in Greater Los Angeles include a steel plant with an annual capacity of 403,000 tons of ingots and a fabricating works with an annual capacity of 21,600 tons of fabricated steel. The ingot capacity is produced in three electric arc furnaces.

C. C. BRANDT

Included in a 1948 expansion program was a continuous all purpose 10-inch bar and rod mill, which was designed to produce a large variety of rod, rounds, squares, flats, channels and angles.

The mill consists of nine roughing stands, four intermediate stands, two looping stands and six rod finishing stands, together with three motor driven vertical edgers. These stands are driven by twelve variable speed direct-current motors, the total horsepower of which is 5500.

PHILLIP SCAROLA

These motors were especially designed for steel mill service, are of the stabilized shunt design, 600 volts and separately excited from a 250-volt bus. Speed regulation, no load to full load, and full load to no load is held within 1½ per cent through the use of series exciters.

Oscillographs showing the impact speed drop on several of these motors are included in the paper, also the speed cone of the mill.

"THE PROCESSING AND DRAWING OF STEEL WIRE"

by P. A. BEAMAN, Manager, Wire Machinery Dept., Morgan Construction Co., Worcester, Mass.

▲ THE steel wire industry processes about 6,000,000 tons per year of rods into wire sizes between 1.0 and 0.001-in. for many uses. The raw material is hot rolled rods in a size range from a little over 1 to $\frac{7}{32}$-in.

P. A. BEAMAN

After the hot rolled rods are cleaned to remove scale, they are reduced in diameter by wire drawing in which the wire is pulled through one or more wire drawing dies by a wire drawing machine. Wire drawing machines are built for single reduction or for multiple reduction. In the latter case they are termed continuous machines. The wire drawing machines cover a wide range of wire sizes, drawing speeds and other requirements. Cooling of the wire as it is drawn continuously is necessary on all products and vital on rope wire.

After a certain reduction, wire must be heat treated. This is done by annealing on low carbon wire and by patenting on high carbon wire. Numerous finishes and coatings are applied to wire of which zinc coating is the most common to produce galvanized wire for fence. Most of the large wire mills make fence and nails. Devices for producing heavy weight wire coils are coming onto the market.

"BLAST FURNACE AND COKE PLANT EXPANSION AT FONTANA"

by CLARENCE R. LOHREY, Assistant General Superintendent, Iron and Steel Div., Kaiser Steel Corp., Fontana, Calif.

▲ OPERATIONS at Kaiser Steel Corp. have been a continuous challenge because of the rapid rate of expansion of a new plant. In its ten years of existence, Kaiser Steel Corp. has had three major expansion programs which have affected blast furnace and coke oven production and operation. These are: (1) the addition of a seventh open hearth furnace, the second blast furnace and a third battery of coke ovens in 1949; (2) an eighth open hearth furnace and tin mill in 1951; and (3) the addition in 1953 of the ninth open hearth, the third blast furnace and two more batteries of coke ovens.

C. R. LOHREY

At the time the plant started operations in 1943, the operators were confronted with a combination of raw materials that were somewhat unfamiliar. Coking coal came from the Sunnyside mine in Utah, and provided an extremely weak coke physically. It was necessary to develop a blend of coals, with the Sunnyside as the principal ingredient, in order to beneficiate the physical properties of this coke.

Blast furnace ore was obtained originally from the Vulcan mine located in the Mojave Desert, some 200 miles from the plant. Later a great portion of the ore came from the Utah Construction operation in Utah, until finally in 1950, after the development of our mining operations at Eagle Mountain, all blast furnace ore comes from that source.

Each of these ores required specific treatment or preparation to obtain economical blast furnace practice.

The demand for more coke from existing facilities in 1950, accelerated our investigation of the coking rate of Western coals, particularly the coal from our Sunnyside mine in Utah. Successful blast furnace practice was attained with 16-hour coke as compared with the 20-hour coke which originally was considered optimum as to coking cycle. This operating practice developed into a cost reduction equivalent to the difference in the price of purchased coke compared to plant coke cost on 280 tons per day during 1950, 1951 and 1952. A further capital savings was realized from this practice in the blast expansion program to the extent of the cost of construction of 55 coke ovens.

"ATOMIZATION OF LIQUID FUEL WITH HIGH PRESSURE GAS"

by GEORGE GROSVENOR, Open Hearth Superintendent, Colorado Fuel & Iron Corp., Pueblo, Colo.

G. GROSVENOR

▲ THE use of high pressure natural gas at Colorado Fuel and Iron has been a development which has taken place in a series of steps since 1949.

All preliminary work was done on small scale models and operated in the open which permitted a close study of flame patterns. When the desired flame pattern was obtained, a full scale model was built and placed on No. 16 furnace. This resulted in the use of a double gun burner. The bottom section of the burner is essentially a venturi with an air port through the burner shell, opening inside the furnace, which permits the use of superheated air from the uptakes. This results in a short compact flame of high temperature and radiation. The angle and shape of the nozzle block in the top gun projects the high pressure gas and fuel oil mixture through this area of maximum temperature, where the high kinetic energy content causes very rapid mixing and produces a high rate of flame propagation of the entire fuel input.

After the preliminary work was completed and a furnace crew selected for the trial, the first burner was put on No. 16 furnace in September 1952, using natural gas at 130 psi pressure. In October the production on No. 16 furnace was increased from 9,586 net tons to 10,373 net tons with the furnace being down during the month for a shot-gun, or a quick roof. This was an increase of 787 net tons. In January 1953, the monthly record was again raised to 11,073 net tons or an increase of another 700 net tons making a total increase of 1,487 net tons. During this month of January, No. 16 furnace tapped 95 heats with an average tap-to-tap time of 7 hours and 56 minutes, and a charge-to-tap time of 7 hours and 18 minutes, and for one week during this month we tapped 24 heats giving a rate of 404 net tons per furnace day or 31.98 tons per hour per 1,000 square feet of hearth area. During this record performance, we tapped two heats in 4 hours and 55 minutes with 2-hour scrap charging time.

"DIVERSITY OF PRODUCTS OF LOW INDIVIDUAL TONNAGES"

by W. J. McCLUNG, Vice President, Steel Plant Operations, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif.

W. J. McCLUNG

▲ LOW cost to the consumer has been the reason for the tremendous tonnages which the steel industry has produced over the years. Steel has been a cheap commodity.

Not all mills can produce at minimum cost. Conditions vary between one location or area and another. Smaller and older mills located in the far West roll such a wide variety of sections that, while these types of mills should have full tonnages, greater tons per section, etc., such is the exception and not the rule.

Product from these mills is classed as raw material for the ever increasing variety of manufacturing units, the existence of which is the result of an ever increasing population, plus the higher cost to produce and ship this raw material from eastern points to the far west. New industries bring along the need for new sections, sizes, qualities and grades. Many of these new industries' requirements are small. More common sections, such as reinforcing bar and light structurals, do not present too great a problem. The great diversity comes from other merchant bar products.

Because many western mills were built to supply certain definite requirements, total or all-out production from these mills was not anticipated; when labor was cheap, the mills were able to make costs without high production.

The paper gives operating data from a number of typical western mills, further emphasizing the problems involved in operations in this area.

"ELECTRIC SYSTEMS FOR MAIN DRIVES"

by W. E. MILLER, Manager, Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

W. E. MILLER

▲ ROLLING mill drives are continuing to increase in horsepower. These increases are the result of efforts to obtain greater output from each mill in the rolling process from the reversing slabbing mill to the strip temper mill, and from the blooming mill to the rod mill. The increase in production is being obtained by operating at higher speeds and by better utilization of the rolling mill itself. Both factors increase drive horsepower since they both result in the drive doing more work.

As the horsepower has increased, so has the electrical content of the installation and so has the interest in the electric drive system. At the same time labor costs have been changing with respect to material and equipment costs. In control systems, tremendous advances have been made in the methods of analysis. New tools, such as the magnetic amplifier, have found wide application. Even newer tools, like the transistor, hold forth the hope for systems with present-day electronic system performance and with the ruggedness and reliability characteristic of today's magnetic amplifier and rotating regulator systems.

Today's main drive systems feature increased and improved automation and instrumentation. The higher operating speeds require these features. Improvements in quality control, per cent yield, and tonnage justify them. They can be built into the system for a few percent of the total investment. They remain on guard monitoring performance during the lifetime of the installation, and undoubtedly pay for themselves many times.

In today's terminology, the main drive electric system includes everything electric associated with the blooming mill, the hot strip finishing mill, the cold reduction mill, or whatever the mill being studied. For a d-c drive, the electric system includes the a-c to d-c conversion equipment, the main drive motors, and all the regulators, control, switchgear, etc. After all, each is important to the successful operation of the mill and should be selected and engineered with the overall system requirements in mind.

Changes in economic and technological considerations make worthwhile a review of the requirements of modern rolling mills and an evaluation of the electric system features best suited to fulfill today's production, labor and quality-control requirements.

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By H. A. ROBERTSON, Refractories Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

REFRACTORY TYPES AND APPLICATIONS

. . . . selecting the right refractories for the varied steel plant applications requires good engineering judgment . . . .

▲ ESSENTIALLY the refractories of today are heat-resisting clay and mineral products, whose prime function is to provide the structure or lining for furnaces that heat, melt and generate. Broadly speaking, any material that can be heated slowly to 2700 F without showing obvious signs of fusion, may be classified as a refractory.

A wide variety of refractories are used to carry out the many processes required for the manufacture of steel. Some of these refractories must resist extremely high temperatures, some the attack of acid or basic slags, and some, the abrasion of raw materials and high velocity gases. Their properties must vary within wide limits, as must their size and dimensions.

DESCRIPTION OF THE PRINCIPAL COMMERCIAL REFRACTORIES

Fireclay brick — Of all the commercial refractory materials, fireclay refractories are used in by far the largest quantities. Chemical composition as well as physical properties of fireclay brick vary over a wide range. However, for general classification of the various types of fireclay brick, the standards adopted by the American Society for Testing Materials has been found to be practicable.

The four principal classes of fireclay brick are:

1. Low Heat Duty — with a softening temperature not lower than 2775 F.
2. Intermediate Heat Duty — with a softening temperature not lower than 2975 F.
3. High Heat Duty — with a corresponding softening temperature of 3075 F.
4. Super-Duty — with a corresponding softening temperature of 3175 F.

High heat duty or first quality fireclay brick are generally used in furnace construction where varying conditions of service may be expected. For the most part, the difference in price between high heat duty fireclay brick and those of lower quality is so little, relatively, that the former may be used with economy. A good example of this is the desirability of using high heat duty fireclay brick in many heating furnaces, in which temperatures may not be sufficiently high to indicate the use of a brick as refractory as those of the high heat duty class. However, the furnaces are used for many years, and during that time, shutdowns or varying temperature conditions may induce spalling of the brickwork. High heat duty fireclay brick have a much higher resistance to thermal spalling than intermediate or low heat duty brick, and accordingly their use may be fully justified in the economy study of the furnace.

Where conditions are so severe that even the best of high heat duty fireclay brick do not serve economically, super-duty fireclay brick, or high-alumina refractories, may be employed to advantage. One of the principal properties of super-duty fireclay brick is their high resistance to thermal shock. In addition, they are considerably more refractory than brick of the high heat duty class.

The usual classification of high-alumina brick starts with an alumina content of 50 per cent. By way of comparison, super-duty fireclay brick contain 42 per cent alumina. As the alumina content of a refractory is increased, the refractoriness increases proportionately. High-alumina brick are used in the steel industry in relatively small amounts, as compared to high heat duty clay brick or even super-duty clay brick. However, for unusually severe conditions, high-alumina brick of the 60 per cent alumina class, or of the 90 per cent alumina class, may be used to very good advantage. In addition, there may frequently arise the need for added refractoriness, resistance to chemical attack, or other properties, which the high-alumina brick provide.

Silica brick — Silica refractories are manufactured from silica rock or quartzite. Chemical composition and physical properties are important. The quartzite is bonded with 2 to 3 per cent lime, and the bricks are fired to temperatures which will convert the quartz to other forms of silica which are stable at high temperatures. Since this conversion results in an expansion, it is important that the brick be well burned, so that they will not expand excessively in service. In chemical composition, the brick will show less than 1 per cent alumina, 1 per cent iron oxide, 2.5 per cent lime and the remainder silica.

Silica refractories are noted for two properties: first their ability to withstand load to high temperatures and, hence, their suitability for construction of arches, and second the relationship of their thermal expansion to their spalling resistance. Silica refractories must be heated slowly to 1000 F to prevent spalling. However, probably no other refractory equals their excellent spalling resistance at temperatures higher than 1000 F as encountered, for example, in the open hearth roof. They are so refractory that they can be used safely in furnace roofs at temperatures up to their melting point.

Based on important discoveries concerning chemical

composition, a super-duty silica refractory was placed on the market several years ago. It is to be recommended especially where the brick are used at such temperatures as will melt or cause excessive slagging to brick of lower refractoriness. This includes the basic open hearth furnace roof where super-duty brick may be expected to outlast conventional brick by 20 per cent, especially where roof temperature controls are used. Super-duty silica has a higher melting temperature of at least 50 F. These brick are held to a chemical analysis specification of a total of 0.5 per cent maximum of alumina plus titania, plus alkalies.

Semi-silica brick — In addition to straight silica brick, considerable use is made in steel plants of silica-clay or semi-silica brick containing 75-80 per cent silica. Such bricks are made from natural occurring sand-clay deposits in New Jersey. Their properties are intermediate between those of silica and fireclay brick. They are essentially volume-stable in use, have a considerable higher thermal shock resistance than silica brick, and tend to glaze very readily when used in reheating furnace roofs. They possess another useful property, which is a high resistance to penetration by molten slags. However their use is limited to furnaces operating at maximum temperatures of 2700 F.

Basic refractories — Commercially the term "basic refractories" includes magnesite and chromite refractories. Chemically, magnesia is strongly basic and chromite is almost neutral. However, most chrome refractories, as now made, contain added magnesia and are mildly basic and some types of magnesite refractories contain chrome ore. Since there is no longer a sharp dividing line between magnesite and chrome refractories, it has become customary industrially to regard chrome as one of the basic materials.

The distinguishing characteristics of this group of refractories are the following:

1. Great resistance to chemical attack by basic oxides — such as iron oxide, lime, magnesia, soda, potash, and basic slags.
2. High melting point — higher than that of any alumina — silica refractory.
3. High rate of thermal expansion — two to three times that of fireclay brick.
4. High density — 165 to 200 lb per cubic foot.
5. High thermal conductivity, especially in compositions consisting mainly of magnesite.
6. Lower resistance to the spalling effects of thermal shock than is possessed by fireclay brick.

The several types of commercial basic refractories have been developed through the blending of available raw materials and by various manufacturing techniques to emphasize specific physical properties and usually to meet specific requirements. Some of the various types are as follows:

1. Magnesite brick containing 85 to 95 per cent magnesia are formed under pressure to high density and hard burned in oil-fired kilns to develop maximum strength and freedom from shrinkage. The magnesia is mainly in the form of crystals of the mineral periclase.
2. Chrome brick composed entirely of chromite are formed and burned by processes similar to those used in making magnesite brick. The chromic oxide in the ore — usually between 30 and 40 per cent — is combined with other oxides in a highly refractory spinel.
3. Magnesite-chrome brick are those in which preburned magnesite and chemical binders are blended with relatively small amounts of selected chromites. The brick are formed on presses in steel dies under extremely heavy pressure, and are not burned. They are the most resistant of all basic refractories to the spalling effects of rapid changes in temperature.
4. Metal encased bricks consist of a chemically bonded magnesite-chrome brick with a casing of mild steel applied to two, three, or four faces. In service, the steel of the casing oxidizes and combines with magnesia of the brick to form magnesioferrite. As a result, a strong monolithic bond is produced which contributes greatly to the stability of the construction and to its spalling resistance.
5. Chrome-magnesite brick are composed of chromite and magnesite with the less costly chromite constituent predominating. Brick of this class are available in two types: one, chemically bonded brick which have relatively greater resistance to spalling, and two, hard burned brick which have relatively greater strength and load carrying capacity at high temperatures.
6. Dead burned magnesite and dolomite are available in granular form. These are widely used for making and maintaining the bottoms of basic open hearth and electric furnaces.
7. Chrome ore is available in the form of prepared ramming material for furnace hearths, and of finely ground furnace chrome for laying chrome and magnesite brick and for hot-patching furnace walls and banks.
8. Prepared materials for open hearth and electric furnace bottoms are made both from dead-burned magnesite and from burned dolomite, with added ingredients. The magnesia content ranges from 65 to 95 per cent. These materials, after being dampened with water, are rammed into place cold to densities of 160 to 180 lb per cubic foot. They attain a strong bond merely upon drying. At furnace temperatures, the cold set is replaced by a sintered bond with further increase in density. Because of their high density and quick setting properties, materials of this class are widely used also for hot patching and for repiping tapholes.

Insulating materials — Improved operation and economy of many furnaces have been brought about by the proper use of insulating materials. These advantages result not only from the heat savings possible by better retention of the heat by the insulated furnace structure, but frequently by the lower heat capacity of the furnace, made possible by the use of lighter-weight construction units.

Insulating firebrick are divided into classes dependent upon the maximum hot face temperature for which they are recommended. The insulating brick are manufactured from expanded mica, diatomaceous earth, fire clay, and high-alumina clays. In order to secure the required light weight and insulating properties, combustibles in the form of coke, cork, or sawdust are frequently added. These of course burn out when the brick are fired and give a porous texture.

Coke ovens — The development of suitable refractories for the various parts of the coke oven structure has been an important factor in the growth of the by-product coke industry. The earliest ovens were constructed with fireclay brick. Later, Semi-silica brick were found to give better service. However, for many years, in all American and Canadian plants, the oven walls and regenerator walls, have been built entirely of high-quality silica brick. The checkers, charging holes, offtakes, waste heat flues, door linings and lintels consist predominantly of high heat duty fireclay brick. Intermediate and low heat duty brick are used in the pad and top. Approximately 65 per cent of the refractories used in the construction of a modern by-product coke oven are silica brick.

In the oven walls, the brick are subjected to considerable abrasion. Accordingly, it is desirable that silica brick be hard and strong. The manufacture of these brick by the power press process contributes to these properties, in addition to making possible greater uniformity in size and increased density. High density of the brick contributes to increased heat flow through the walls, which is desirable. Air-setting, highly siliceous high temperature bonding mortars of the proper quality contribute to the attainment of a gas-tight structure.

Marked economies in operation of coke ovens can be effected by proper insulation. Both insulating fire brick and bulk insulation are used.

Blast furnaces — The conditions to which refractories are subjected in blast furnaces make necessary rather specialized combinations of properties, which differ for brick to be used in the various sections — the top, the inwall, and the hearth and bosh. For all sections of the blast furnace, good workmanship of the refractories is important, in order to insure very tight and close fitting construction. Another general and important requirement is the use of adequate and proper water-cooling, inasmuch as under intensive slag attack, the life of any refractory must necessarily be limited, unless so protected.

Top section — In this section the refractories must be highly resistant to abrasion. The brick should therefore be mechanically strong and hard. Another factor, which must be taken into account, is resistance to disintegration by carbon monoxide gas. It has been found that under certain conditions, this gas in the pores of the brick will dissociate and deposit carbon. Stresses may be built up which are sufficient to cause the brick to disintegrate. The reaction takes place most actively in those parts of the lining where the temperature is within the range of 700–900 F. Consequently, in the top section, any disintegration which might occur would take place relatively near the interior surface of the brick lining. As a means of rendering refractories resistant to the disintegrating effects of carbon monoxide, special firing of the refractories has been found effective.

High heat duty fireclay brick are generally used in the top section, although a number of linings have been installed with super-duty brick of extra hard burn. Low porosity and especially low permeability to gas penetration are desirable properties of the brick for the top.

Inwall section — The temperatures in the inwall are higher than in the top. However, resistance to abrasion and to disintegration by carbon monoxide is also an important requirement in the refractories for the inwall section. The blast furnace brick used in this section are high heat duty fireclay brick of hard burn or of a special burn. Super-duty brick of extra hard burn are being tried out in several installations. Carbon monoxide disintegration, if it occurs, will take place somewhat farther back from the innersurface of the lining than in the top section, since the critical temperature range is farther back.

Hearth and bosh section — In the bosh section of the blast furnace, the refractories are exposed to the most severe conditions of both temperature and slag attack. Here, high refractoriness is essential. Low permeability and porosity are also important properties. High resistance to carbon monoxide disintegration is not generally an important consideration in this section. In the bosh section, the brick used are usually high heat duty brick of the hearth and bosh type. In the hearth, volume stability of the brick at high temperature is important. Carbon blocks are now being used in the hearths of a number of furnaces. These show promise, although as yet the background of experience is insufficient to provide a complete estimation of this refractory.

Blast furnace auxiliary equipment — In the hot blast mains, bustle pipe, offtakes, and downcomers, the prevailing temperatures are not high, but the refractory linings may be subjected to considerable abrasive action by the dusts carried in the gases. Consequently, strong, tough brick resistant to abrasion are required.

In blast furnace stoves of modern design and high efficiency, there is a tendency toward higher operating temperatures and severe fluxing conditions. High heat duty fireclay bricks of high density and strength and good workmanship are used in the stove linings and checkers. In many stoves, super-duty fireclay brick have been used to advantage in the combustion chambers and in the upper courses of the checkers. Semi-silica brick are also being used in stove combustion chambers, domes, and in the middle courses of the checkers.

Basic open hearth furnaces — Roofs of basic open hearth furnaces conventionally are sprung arches of silica brick with ribs of longer brick at intervals of three or four courses. Bonded roof construction without ribs, is also commonly used. Roof thickness varies from 12 to 18 inches. Thicker roof sections or shoulders are frequently provided, adjacent to the back and front walls where the most severe erosion often occurs. The roof skewbacks, are set in structural steel channels, often water-cooled, attached to the furnace buckstays, so that the dead weight of the roof is not carried by the front and back walls. In recent years, better balanced life of the roof has been attained by the use of super-duty silica brick in sections of maximum erosion and the use of metal encased basic brick in skewbacks and adjoining courses of roof brick.

Front walls are of small total area, but are subjected to extremely severe service conditions. The piers are exposed to flame and erosion, to rapid temperature changes and to mechanical abuse when charging. Metal encased magnesite-chrome brick of the chemically bonded type, are commonly used, frequently with steel

sheets in the horizontal joints at intervals of two or three courses. The steel sheets are rigidly attached to the furnace buckstays to prevent the piers from collapsing when undercut at the slag line.

Many modern furnaces have sloping back walls designed to permit their being covered and maintained with chrome ore, magnesite, or dolomite, leaving exposed only a few courses of brick under the skewbacks. Back walls which are thus protected are usually built with chrome-magnesite bricks without steel reinforcing.

Bottoms and banks, comprising the hearth on which the steel is made, usually have a top surface of grain magnesite burned in, one thin layer at a time, with 10 to 15 per cent of open hearth slag added to the magnesite to promote sintering. The bottom and banks are maintained with dressings of grain magnesite or refractory dolomite applied after each tapping of a heat. Prior to 1940, grain magnesite hearths were burned into a total thickness of 15 to 25 inches, the process required some two to three weeks at maximum operating temperature before the first heat could be charged. More recently, it has become general practice to use prepared ramming mixes, either to the final contours of the hearth, or to such a level as to leave 4 to 8 inches of working surface to be burned in with grain magnesite and slag. The sub-bottom is of masonry construction, with burned magnesite or chrome-magnesite brick in the top courses and with one or more courses of high heat duty fireclay brick and insulating fire brick between these and the pan.

Port ends are generally built of silica brick, except for panels of basic brick in the end wall bulkheads. A recent development has been the construction of many furnaces with basic brick used exclusively in the ports and in the sections of roof over the ports. Metal encased, burned or chemically bonded, basic brick have been used in this construction with sectionally supported walls, and with suspended arches in the roof sections and under the chill boxes.

Fantail arches leading from the slag pockets to the regenerators are constructed of silica brick or of high-alumina brick. The regenerator chambers are usually built with high heat duty fireclay brick. A wide variety of checker settings are employed using dense fireclay brick. Super-duty fireclay brick are frequently used in the top checker courses.

Soaking pits — Operating temperatures in soaking pits are relatively moderate, but the refractories in these furnaces are exposed to severe service conditions, as the result of opening and closing the pits. This causes rapid temperature fluctuations and a sudden drop in temperature when cold ingots are charged. The coping or edge of soaking pits is built of high heat duty fireclay brick tile, to withstand impact from ingots and charging tongs and wide temperature variations. The walls of the pits are usually constructed of silica firestone, spall-resisting silica brick, semi-silica brick, and high heat duty or super-duty fireclay brick. The base of the walls is usually built with basic brick, either plain or plated, to resist the corrosive action of the molten slag and scale attack. The furnace covers, either sprung arch or flat suspended, are lined with spall-resisting fireclay brick, super-duty fireclay brick or, semi-silica brick. Recently many suspended covers have been laid-up with plastic firebrick or high temperature castables. Castables are now available to withstand temperatures up to 3200 F.

Reheating furnaces — The triple-fired multi-zone continuous slab reheating furnace design, demands a wide range of refractories for efficient operation. The hearth is exposed not only to a high temperature, but also to attack by scale, and is made from a chrome plastic, rammed on fireclay bricks, which in turn rest on insulating concrete.

The charging end of the furnace is usually built with first quality fireclay brick, both roof and sidewalls. The heating and soaking zones require super-duty fireclay brick in the roof and often in the sidewalls. The more refractory super-duty clay brick have a higher porosity which gives internal "play" and accounts in part for their greater freedom from thermal shock spalling. The difficulty with this type of brick is that unless it has been particularly hard fired, it shows after contraction in service. This leads to open joints through which the flame can penetrate and attack the brick at the sides as well as at the end, leading to stress concentrations at the junction between the vitrified face and the cold end, and consequent spalling losses. Such shrinkage is said to be more severe with bricks whose alumina content has been artificially raised by adding bauxite to medium alumina clays. Where it is absolutely essential that the sheets or other products be kept free from brick particles, sillimanite brick of exceptionally high spalling resistance may be employed in the roof in spite of their high initial cost.

In bar and rod reheating furnaces, operating temperatures are moderate and spall-resisting fireclay brick are commonly used. Semi-silica brick give excellent performance in sprung arch or suspended roofs and sidewalls where operating temperatures do not exceed 2700 F. High temperature castables are commonly used for forming burner blocks and occasionally entire walls are poured with this refractory.

Annealing furnaces — The temperatures which are used for annealing are such that frequently advantage may be taken of the many desirable properties of insulating fire brick and lightweight refractories. The first consideration is whether it is desirable to have a heat reservoir provided by the construction, or whether low heat capacity and sharp response to temperature change is desired. If heat storage is a prime consideration, the high heat capacity of dense refractory brick may require their use. Insulating refractories have much lower heat capacities than refractories of the usual density, and their use leads to low heat storage and to rapid response to temperature variations.

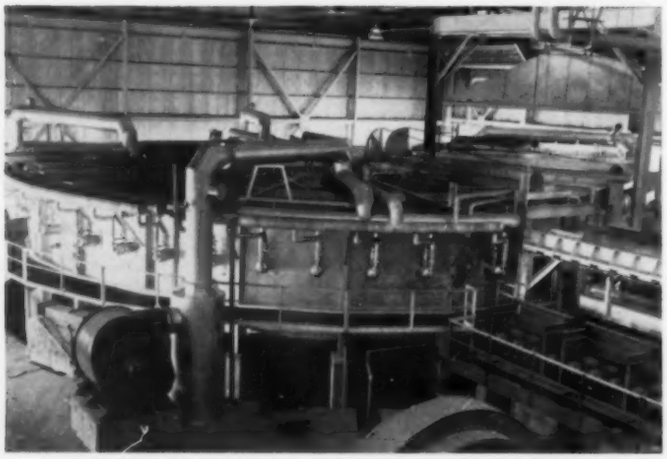
Castables are also used in annealing furnaces to form monolithic linings of refractory concrete. Where the temperature of operations permit, refractory castable may be used for the entire side walls or arch of the furnace.

In most steel plants, the life, efficiency, and capacity of equipment has been determined by the ability of refractories to perform their allotted jobs. This has stimulated the technical development of refractories to the present high level of quality and broadened service. A large amount of research has been carried out in order to improve the grade of refractories, and to discover new materials from which practical refractories can be made.

The modern industrial building covers more than ten acres under one roof, including billet yard and pipe storage.

NEW CF & I SEAMLESS TUBE MILL

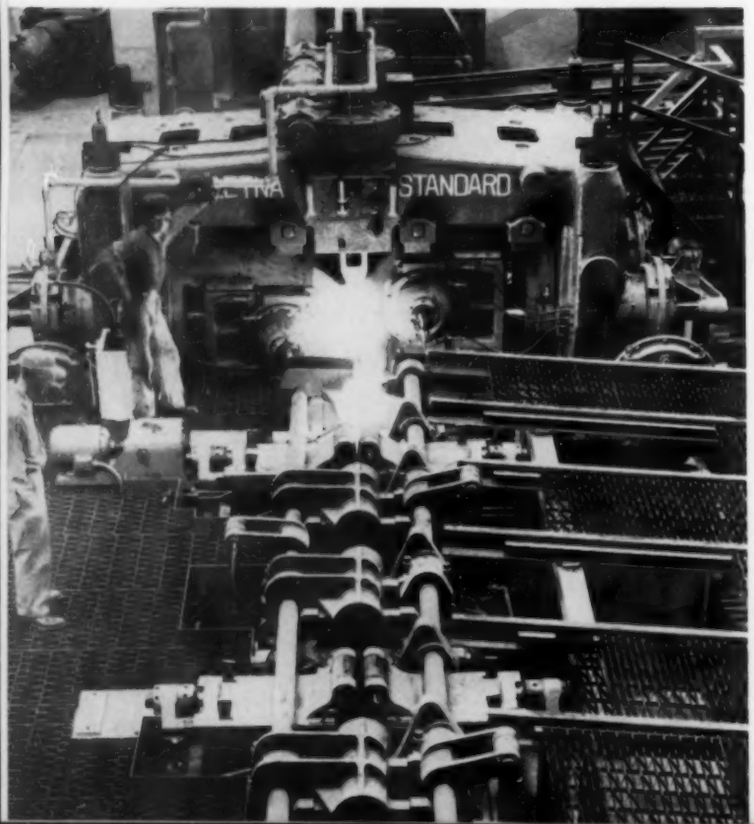
▲ Colorado Fuel and Iron Corp.'s new seamless tube mill (see IRON AND STEEL ENGINEER, October, 1953, page 165) is the first of its kind west of the Mississippi, and will be an important supplier of seamless steel tubing and casing to the oil and gas industries of the western United States and Canada. The mill is designed for monthly production of 15,000 net tons.



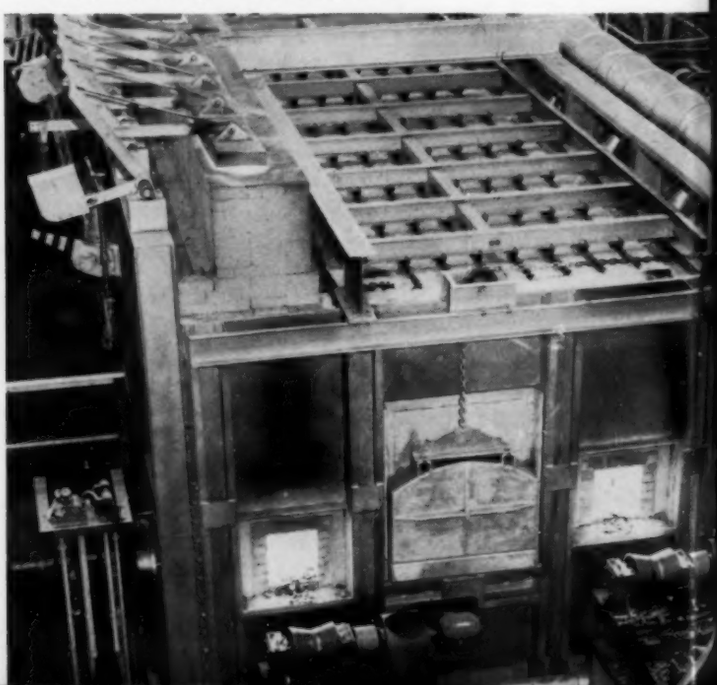
A giant 70-ft rotary furnace, one of the largest ever constructed, has been installed in the new mill. This revolving hearth furnace is designed to give a maximum degree of accuracy and uniformity in the heating process.

No. 2 piercing mill is shown above. Each of the two 35-in. piercing mills weighs 304 tons, is driven by a 3000-hp motor.

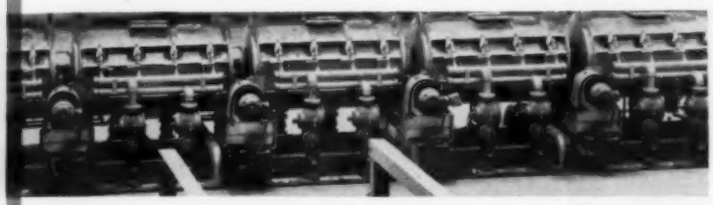
Billets are pushed into No. 1 piercing mill by means of an air-operated ram. The rolls grasp the hot billet, revolve it rapidly and pull it forward over the piercer.



A reheating furnace is provided to bring the temperature of the pierced billets up to about 2200 F before they are put through the rolling mill.

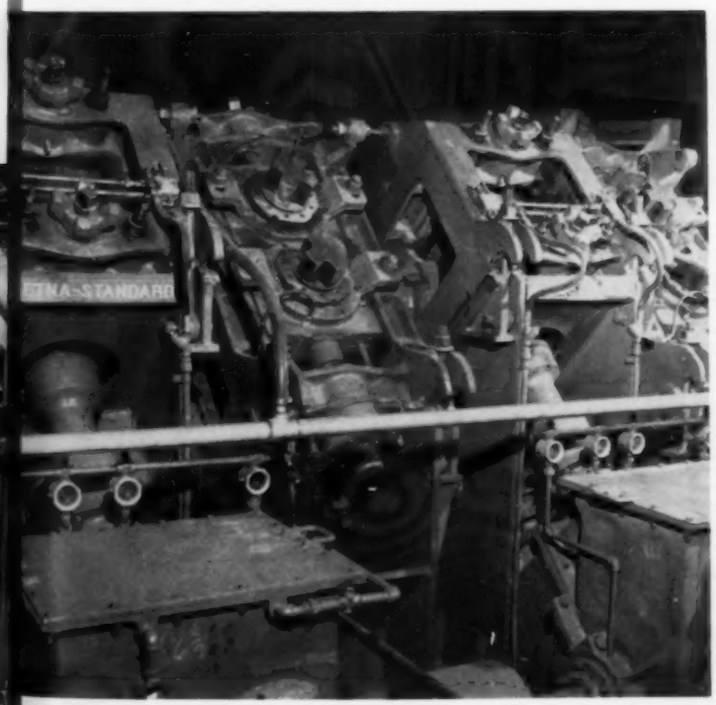


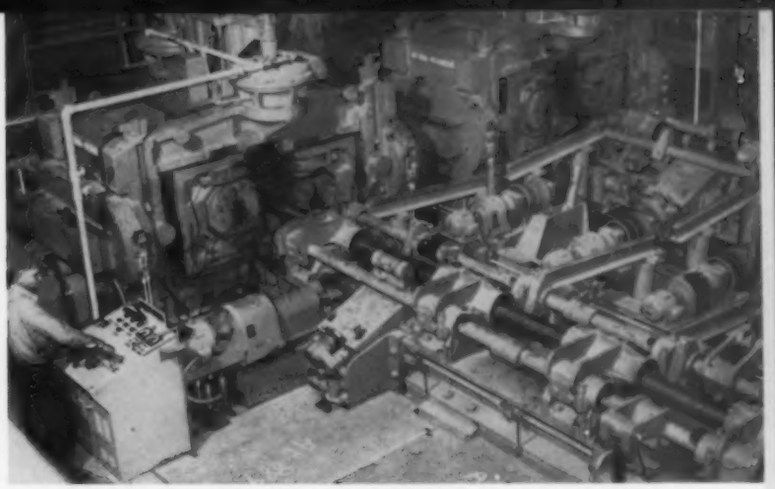
A 30-in. rolling mill, powered by a 1500-hp motor, processes the pierced billets, lengthening the tubes and making their walls thinner.



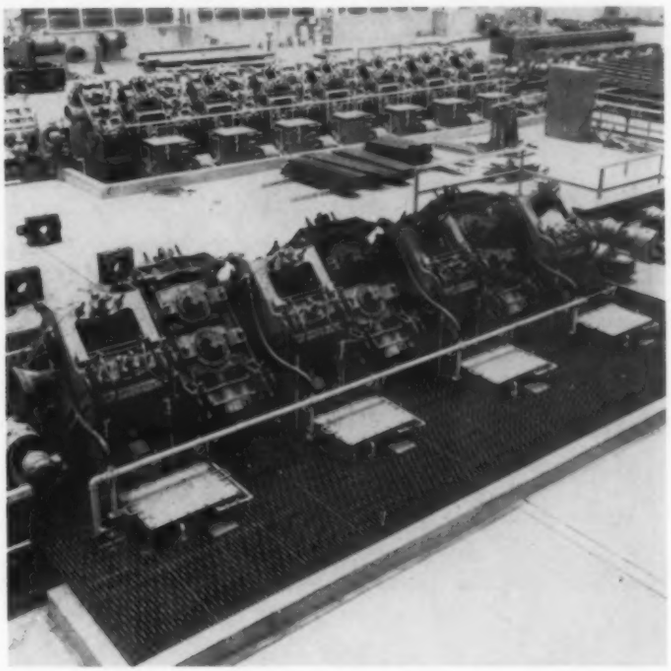
The second series of reheat furnaces, located ahead of the reducing mill, consists of 15 barrel-type furnaces in line with the mill. These furnaces are designed to heat tube from 1400 to 1900 F at 250 fpm.

The 14-stand reducing mill is used for tube sizes 3½ in. outside diameter and smaller.



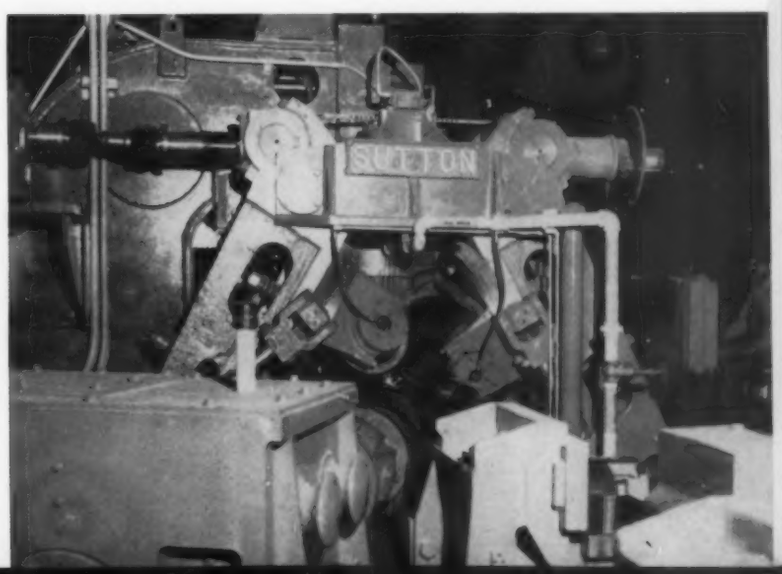


Two 30-in. reelers, which follow after the rolling mill, remove defects, such as light outside and inside scratches.



A seven stand continuous sizing mill is used for final sizing of large tubes over 4 in. outside diameter.

Finishing equipment includes two seven-roll rotary straighteners.



Eric L. Anderson

PRESIDENT, 1954

ASSOCIATION OF IRON AND STEEL ENGINEERS

ERIC L. ANDERSON has been associated with the iron and steel industry throughout his entire business career. He was born in England and came to the United States in 1914. He started work as an office boy in the general office of the Bethlehem Steel Co. at Sparrows Point in 1917, and in 1918 was moved to the electrical department at Sparrows Point, as an electrician apprentice. He worked up through the ranks at this plant to the position of Assistant to the Electrical Superintendent. In 1937 he was transferred to the Johnstown plant of Bethlehem and took the job of general foreman, becoming assistant electrical superintendent in 1939 and then being appointed superintendent of the electrical department in 1940. He has served in this capacity until the present time. Mr. Anderson attended the Baltimore Polytechnic Institute and also took night school courses at Johns Hopkins University.

The President's Message

We enter 1954 in the midst of a period of business readjustment, with hopes for a return to the normal, healthy, competitive situation which has not existed for a number of years.

The keynote of a successful operation is good quality, low cost production. Such an operation poses a challenge to the ingenuity of all branches of engineering, for it is the engineers who must plan for safe, efficient and economical installations that will meet management requirements.

The Association of Iron and Steel Engineers was founded 47 years ago for the express purpose of providing a medium for the exchange of ideas and the discussion of electrical problems pertaining to the steel industry. Over the years it has expanded, and now encompasses all branches of steel mill engineers.

The officers and staff of the Association are ever trying to be progressive and to present papers and publications that are timely and interesting. District section meetings, plant visitations, the spring meeting and the fall convention, with its exhibits, bring to you the latest developments that equipment manufacturers have to offer, and present the opportunity of making many personal contacts with other men in the industry.

The Association of Iron & Steel Engineers, with the full cooperation of its membership, can be an effective means to help solve the problems facing the industry today.

ERIC L. ANDERSON
President, AISE

JOHN H. VOHR
First Vice President

W. H. COLLISON
Second Vice President

JAMES D. O'ROARK
Treasurer

NEWLY ELECTED OFFICERS AND DIRECTORS

JOHN H. VOHR was graduated from Cornell University in mechanical and electrical engineering in 1916 and became associated with the New York State Railways as an electrical engineer. After serving in World War I, he joined the American Sheet and Tin Plate Co. at Farrell, Pa., and later was transferred as assistant superintendent of strip mills to the company's plant at Gary. After leaving the company in 1931, he was engaged with the installation and operation of the wide strip mills of the Inland Steel Co. and Youngstown Sheet and Tube Co. In 1936 he joined the Granite City Steel Co., Granite City, Ill. as superintendent of the hot and cold strip mills and was promoted in 1937 to general superintendent of plants. In 1942 he went with the Carnegie-Illincis Steel Corp., being stationed at the general offices in Pittsburgh until his appointment in 1943 as assistant general superintendent of South Works of Chicago, Ill. In 1949, he was promoted to the general superintendency of Gary, Ind. Steel Works.

W. H. COLLISON was graduated from the University of Cincinnati in 1926 with a degree of chemical engineer. He took a cooperative course and he worked in the coke plant of Pittsburgh Crucible Steel Co., beginning in 1924, continuing after graduation until 1927. He then went to the Central Alloy Steel Corp., Massillon, Ohio, as heater in the coke plant, and was made turn foreman shortly thereafter. In 1935, Mr. Collison went with the Pure Oil Co., Marcus Hook, Pa., as a chemist. Following this he came to Detroit as boss heater for the new coke plant of Great Lakes Steel Corp., being subsequently promoted to assistant superintendent and later to superintendent of the coke plant. In 1951 he was made assistant general superintendent, blast furnace division.

JAMES D. O'ROARK was born in Broadway, Va., and received grade and high school education in Covington, Ohio. He was graduated from Ohio State University in 1926 with a degree in electrical engineering. After graduation he was employed in the student engineer training course and test floor from 1926-1930 at Westinghouse Electric Corp.'s East Pittsburgh works. He has been employed by Weirton Steel Co. from 1931 to present date as electrical field engineer, electrical foreman of strip steel and sheet mill dept., assistant electrical superintendent, electrical superintendent, and assistant manager of service and maintenance, which last position he now holds.

LEONARD LARSON was employed as draftsman at Jones & Laughlin Steel Corp. and Carnegie Steel Co. in Pittsburgh, Pa. from 1913 to 1917, while attending night school at Carnegie Tech. He moved to Massillon in 1917 as draftsman for Central Steel Co., was appointed chief draftsman in 1918, and assistant chief engineer about 1923. He was appointed assistant chief engineer for Central Alloy Steel Corp., in 1926 in merger between Central Steel Co. and United Alloy Steel Corp., and was appointed chief engineer in 1929. He served in this capacity for Central Alloy Steel Corp., and Republic Steel Corp., after merger in 1930, until 1939, when he was transferred to Cleveland District as district chief engineer which position he now holds. During period from 1933 to 1936, he spent about one year on special open hearth work for the corporation, and about two years in the operating department as divisional superintendent at the Massillon Steel plant.

EMIL KERN was graduated from the University of Stuttgart, Germany, in 1926, and began his career as a machinist and designer with Mesta Machine Co. in 1930. He became associated with Reynolds Metals Co. as chief mechanical engineer in 1945, and joined the Allegheny Ludlum Steel Corp., Pittsburgh, Pa. as chief engineer the following year. In May 1949, he was elected a vice president in charge of engineering of the Allegheny Ludlum Steel Corp.

JAMES A. BELL was graduated from Bethlehem High School in 1906 and became draftsman apprentice in the engineering department of Bethlehem Steel Co. In the years to follow, he assisted in the design of a number of large rolling mills with that company, and was connected with the heavy machinery, ordnance and construction engineering departments. He also worked in the mills at Bethlehem's Saucon division. In 1938, he was appointed chief draftsman, and seven years later was advanced to assistant chief engineer. He was promoted to his present position of chief engineer of the Bethlehem plant in 1946.

LEONARD LARSON
Secretary

EMIL KERN
Director-at-Large

JAMES A. BELL
Director

GEORGE D. BRENGELMAN
Director

HARRY W. CLARK
Director

JULIUS E. GRAF
Director

ASSOCIATION OF IRON AND STEEL ENGINEERS 1954

GEORGE D. BRENGELMAN was born in Nashville, Tenn. He received an engineering degree at Vanderbilt University in 1937, and after graduation was employed by the Tennessee Coal, Iron & Railroad Division, U. S. Steel Co., as a student engineer in the mills department of Ensley works. He served as practiceman, foreman mills service, assistant master mechanic and assistant department superintendent. In February 1950, he was promoted to assistant to the general superintendent. In May 1952 he was promoted to assistant general superintendent of Ensley works which position he now holds.

HARRY W. CLARK, a native of Detroit, Mich., obtained his technical education through various Michigan educational institutions, including the Henry Ford Apprentice School. His metallurgical experience has been entirely with the Ford Motor Co. steel operations and he has been associated with the Rouge plant of that company since 1934. In 1942, he assisted in the organization of the quality control department in the open hearth, soaking pits and rolling mill. His promotion to his present capacity as open hearth metallurgist and supervisor of the metallurgical quality control section in the aforementioned operating units came in 1946.

JULIUS E. GRAF was born in Pittsburgh and is a graduate of the Carnegie Institute of Technology. Mr. Graf became associated with the American Sheet and Tin Plate Co. in 1911 and worked up to the position of chief engineer of that company. In 1936 at the time of the merger of the American Sheet and Tin Plate Co. with the Carnegie-Illinois Steel Corp., he became assistant chief engineer of the newly formed Carnegie-Illinois Steel Corp. Mr. Graf became affiliated with the Treadwell Co. in 1939. In October 1940, Mr. Graf was appointed assistant chief engineer of the Jones and Laughlin Steel Corp., Pittsburgh, Pa. In January 1947 he was made chief engineer, the position he now holds.

CHARLES E. HOMER was born in Provo, Utah. After attending the University in Provo and graduating from Bliss Electrical in 1925, he was employed at the Gary works of National Tube Co. and advanced to the position of foreman of electrical testing. In 1929, he joined the Youngstown Sheet & Tube Co. and through the years advanced to a number of positions which included electrical construction foreman, assistant electrical superintendent, electrical superintendent and is now superintendent of maintenance and power, Indiana Harbor works, East Chicago, Ind.

JAMES N. IMEL was born at Cambridge Springs, Pa., in the year 1907. He received his elementary and high school education in Cleveland, Ohio and was graduated from Bethany College, Bethany, W. Va., in June, 1930. He started to work with the Jones & Laughlin Steel Corp. shortly after his graduation as a student trainee. After holding various jobs in the rolling mills department, he was advanced to the position of general foreman, D.S. Mills in 1937. In April, 1946, he was promoted to the position of assistant superintendent of rolling mills and, on August 1, 1947, was appointed superintendent of rolling mills, Pittsburgh works. He is now superintendent, continuous strip and sheet dept., Jones and Laughlin Steel Corp., Pittsburgh, Pa.

ANDREW F. KRITSCHER was born in 1913 in Philadelphia, Pa. He was graduated in mechanical engineering from the Carnegie Institute of Technology in 1937. At that time he started work as an apprentice engineer for the National Tube Co. at the Ellwood City works. He successively held the positions of fuel and power engineer, seamless mill engineer, and general foreman seamless mills. In 1946 he was transferred to the headquarters engineering staff of the National Tube Co. at Pittsburgh, Pa. as a staff engineer. He became development engineer in 1951 and assistant chief engineer in 1953, which position he now holds.

CHARLES E. HOMER
Director

JAMES N. IMEL
Director

ANDREW F. KRITSCHER
Director

D. C. McCRADY
Director

WALTER V. MAGEE
Director

W. M. SCHUCK
Director

D. C. McCRADY was born in Montreal, Canada. He was graduated from McGill University in electrical engineering in 1936 and then spent two years on the General Electric Test Course. After that he worked several years as sales engineer for Canadian General Electric in mining districts. He spent the following six years as application and field engineer with same company on steel mills and mining equipment. In 1947, he joined Steel Co. of Canada as a general foreman electrical department. He became assistant superintendent in 1948, and superintendent electrical department in 1950, in charge of engineering, construction, shop and maintenance at Hamilton Works.

WALTER V. MAGEE is a native of Zanesville, Ohio. He interrupted his education in engineering at Ohio State University and joined the Army during World War I. He returned to Ohio State after the war and specialized in mechanical engineering. He has been active in the Officers Reserve Corps since 1921. After a number of engineering positions he joined the American Steel and Wire Division, U. S. Steel Co., Cleveland, Ohio, in 1927 as a designer, and later became division engineer construction. He is now assistant chief engineer.

W. M. SCHUCK received his B.S. degree at Lehigh University in 1932. He then became affiliated with the Armco Steel Corp. at their Butler Division plant where he successively held positions in the Industrial Engineering and Maintenance Departments. During the war he served as a Major in the Corps of Engineers in the South West Pacific theatre. On his return in 1946, he rejoined the Armco organization and shortly thereafter was appointed lubrication engineer for the company.

OSBORNE K. SHARP was born in Buffalo, N. Y. Since his graduation from the University of Kentucky in 1932, where he received a degree in metallurgical engineering, he has been with Republic Steel Corp.'s Buffalo plant. After serving in the metallurgical department at Republic, he was promoted to blooming and billet mill superintendent and has served in that capacity from 1942 until the present time. He is one of the charter members of the Buffalo chapter of AISE.

P. E. THOMAS was born in Indiana and was graduated from Purdue University's school of electrical engineering in 1927. Mr. Thomas obtained his early steel mill experience working summer vacations at American Sheet and Tin Plate, Elwood, Ind. He was employed by the Illinois Steel Corp., Gary, Ind. in 1924 as a wireman and later as an electrical testing engineer, taking leave of absence to finish his senior year at Purdue University. In 1929 he left the steel industry to go with Byllesby Engineering and Management Co. as a design engineer and squad boss. From 1932 to 1936 he was employed by the city of Crown Point, Ind., in charge of construction of a water filtration plant. He again entered the steel industry in 1936 in the employ of Carnegie-Illinois Steel Corp., Gary steel works as a design draftsman, design engineer and squad boss. From 1942 to 1944 he was assistant chief engineer and later acting chief engineer for Carnegie-Illinois during the construction and operation of the Gary armor plate plant. After this he was appointed assistant electrical engineer at Gary steel works, later became project engineer and in July, 1947 was appointed to assistant division superintendent of maintenance. In July, 1948 he was named chief engineer of the Gary Works. In 1950 he was made assistant general superintendent of the Gary steel works.

P. L. WALTER was graduated from Purdue University in 1916 with a degree of B.S. in C.E. He then worked as civil engineer, plant engineer, superintendent of construction and chief engineer with The United Furnace Co. After this company's absorption by United Alloy Steel Corp., he became assistant superintendent of power, and superintendent power and combustion. Since this plant became a unit of Republic Steel Corp., he has served as superintendent of power and steam engineer. He holds the present position of superintendent of mechanical department, Canton plants, Republic Steel Corp.

OSBORNE K. SHARP
Director

P. E. THOMAS
Director

P. L. WALTER
Director

National Committees for 1954

ASSOCIATION OF IRON AND STEEL ENGINEERS

General Chairman, Eric L. Anderson

ADVISORY COMMITTEE

Past Presidents, AISE

1907-1908 JAMES FARRINGTON, *Special Assistant to Chief Plant Engineer*, Wheeling Steel Corp., Steubenville, Ohio.
1919 D. M. PETTY, *President*, Philadelphia, Bethlehem & New England Railroad Co., Bethlehem, Pa.
1921 E. S. JEFFERIES, Worcester, Mass.
1923 R. B. GERHARDT, Philadelphia, Pa.
1924 R. S. SHOEMAKER, *Cincinnati District Manager*, Brooks Oil Co., Middletown, Ohio.
1926 G. H. SCHAEFFER, *Consulting Engineer*, Reading, Pa.
1930 F. W. CRAMER, *Consulting Engineer*, Elliott Co., Pittsburgh, Pa.
1931 F. O. SCHNURE, *Electrical Superintendent*, Bethlehem Steel Co., Sparrows Point, Md.
1932 J. J. BOOTH, Pittsburgh, Pa.
1935 W. H. BURR, Coatesville, Pa.
1937 H. G. R. BENNETT, Eustis, Fla.
1938 L. F. COFFIN, *Assistant General Manager*, Bethlehem Steel Co., Sparrows Point, Md.
1939 C. CLARKE WALES, *Chief Project Engineer*, National Tube Div., United States Steel Corp., Lorain, Ohio.
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6900-VOLT POWER SYSTEM FAULT RELAY ANALYSIS

By JAMES A. B. PINNEY
Electrical Design Engineer
Alan Wood Steel Co.
Conshohocken, Pa.

. . . . a system fault analysis is necessary to calibrate the system protective relays to provide minimum interruption of critical circuits . . . .

▲ EXPANDING plant production facilities are invariably accompanied by increasingly complex utilities problems, particularly in an older plant where the services were dictated by engineering principles of the early 1920's. This was the problem at Alan Wood Steel at the beginning of World War II, when increased power demands required that a decision be made on the following two questions:

1. Should the 25-cycle system be expanded by the addition of a new turbo-generator?
   or
2. Should the system be split by the introduction of 60-cycle power in part of the plant?

The latter was chosen, and the steel works division was completely converted to 60-cycle, purchasing all power from the local utility company. A paper on this expansion, entitled "Pioneer Steel Maker Modernizes Power System" (1946 Proceedings AISE p 247) was presented before the AISE Philadelphia District Section in January 1946.

As the plant expanded, project engineering developed around the new 60-cycle system. In 1948 two 125,000

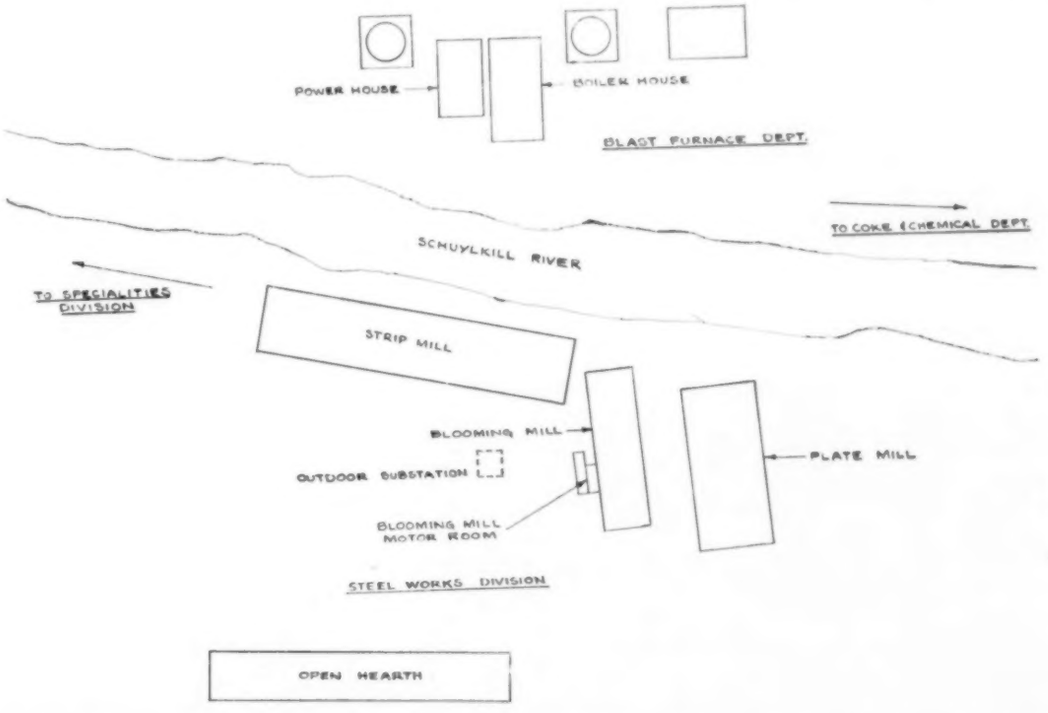


Figure 1 — Schematic shows layout of Alan Wood Steel plant.

pounds per hour high pressure boilers were put into service, initially at low pressure, using blast furnace gas for basic firing, with a new steam line running from the blast furnace to the steel works. The year 1950 saw the advent of a new hot strip mill with additional purchased power facilities.

Thus the pattern developed, and a new 7500-kw, 6900-volt, 60-cycle, extraction turbo-generator was added in August, 1952, operating from the new high pressure boilers, using extraction for blowers, the 25-cycle generators and process, and operating in parallel with the Philadelphia Electric Co. interconnection.

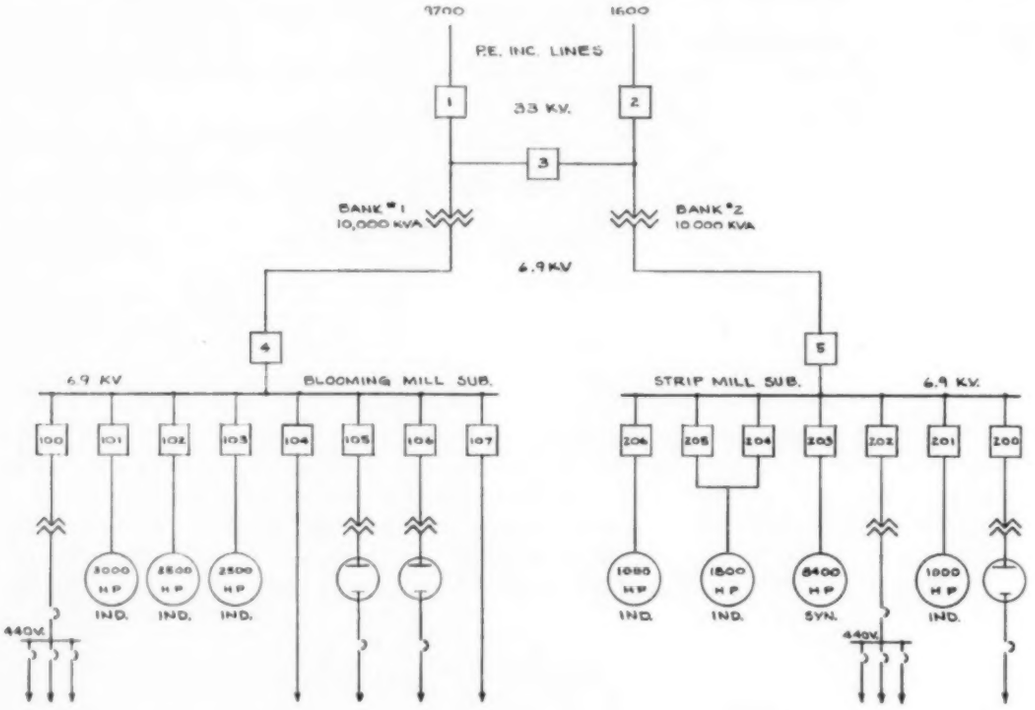


Figure 2 — Single line diagram shows 60-cycle power system before turbo-generator was installed.

The development, economics, and heat balance of this installation are of vital importance, but cannot be elaborated on at this time. However, it would be advantageous to discuss briefly the plant geography and the way the turbo-generator was tied into the steel works system.

Figure 1 shows the plant layout. Two 25-cycle turbo-generators at the blast furnace department make 9000 kw of power available for distribution at 2300 volts to the coke and chemical department, the specialties division, and the steel works division, where a single conversion unit has been retained to furnish emergency d-c power from the 25-cycle system. A single line diagram of the steel works 60-cycle system before the turbo-generator was installed is shown in Figure 2. The two Philadelphia Electric Co. 33-kv lines, No. 1600 and No. 9700, are the sources of power, although they are available for use only one line at a time. Normal operation is with one line breaker open and the other line breaker and the tie breaker closed. The main transformer banks No. 1 and No. 2 are 10,000 kva each and are delta-delta connected. The blooming mill substation supplies the blooming mill, plate mill, open hearth and various plant auxiliaries. The strip mill substation supplies the strip mill only.

The turbo-generator was installed at the blast furnace and tied into the steel works system, as shown in Figure 3, by means of a cross river transmission line adjacent to the already existing 25-cycle lines. This resulted in a new switchhouse at the transformer substation which ties the low voltage side of the transformers together. In the event of a turbo-generator shutdown, the Philadelphia Electric Co. lines carry the steel works and blast furnace loads. Should the power company interconnection be lost, the turbo-generator will carry the blast furnace load and restricted steel works loads. Switching of the 33-kv breakers and the 6900-volt breakers in the new switchhouse, is done remotely from the blooming mill substation.

In paralleling the turbo-generator with the Philadelphia Electric Co. lines, two normal operating procedures are used. If the power company is carrying the system, the turbo-generator is synchronized and paralleled at the blast furnace. If the turbo-generator is carrying the system, the system is synchronized and paralleled with the power company in the blooming mill substation. The latter is accomplished by means of a radio communication system between the control panel at the blooming mill substation, shown in Figure 4, and the turbo-generator control panel at the blast furnace, shown in Figure 5.

As the turbo-generator installation approached completion, the question of relay settings for the circuit breakers arose. The two sources of power in the new system would require an accurate study to obtain relay selectivity and sequential tripping of circuit breakers. By selectivity and sequential tripping is meant, the breaker nearest the fault and separating the fault from the source of power trips first. Should this breaker fail to trip, the next breaker towards the source of power trips, and so on until the fault is cleared. Also, due to the desire to obtain the advantages of a grounded system, the neutral of the new generator was grounded through a 2000-ampere, 10-second resistor. This meant the system had to have ground fault protection and resulted in residually connected ground relays, which

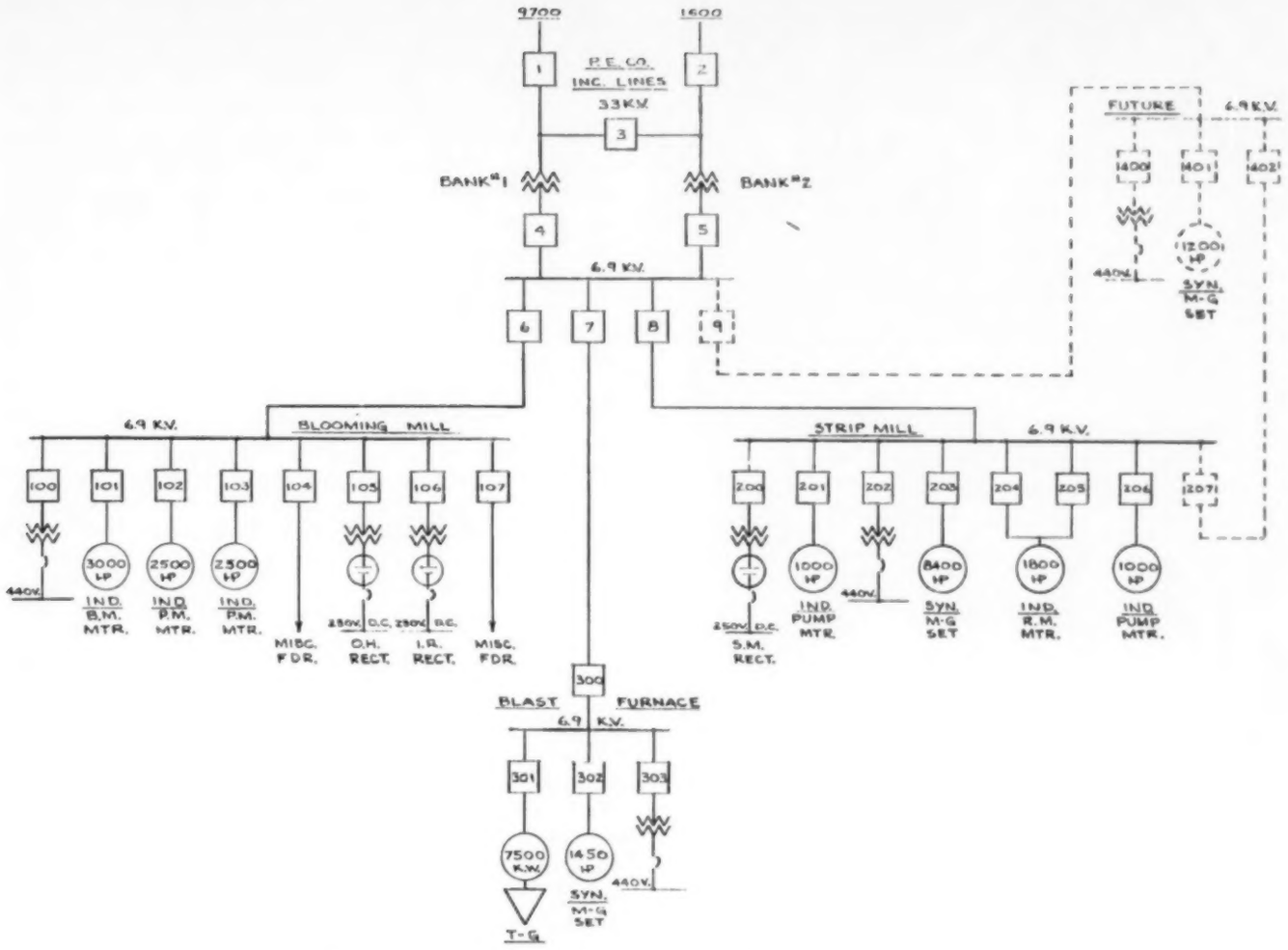


Figure 3 — Schematic shows present 60-cycle power system.

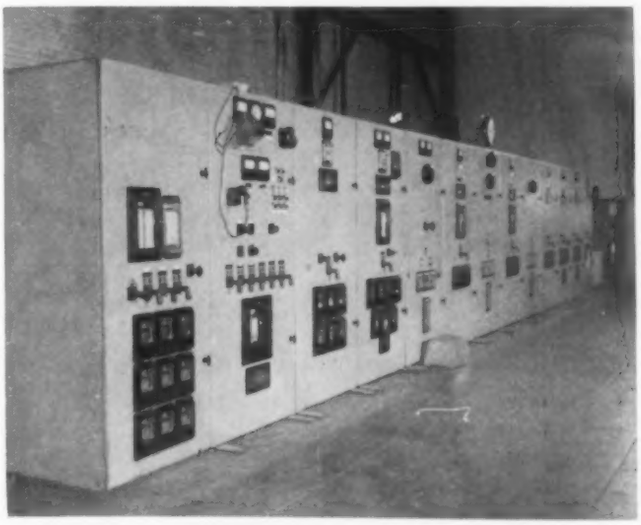
had to be given settings that would permit them to operate selectively also.

Figure 6 is a schematic showing the method of connecting phase overcurrent and residual ground relays. in the current transformer circuit. These relays usually consist of an instantaneous element and a time delay element, whose settings must be obtained by computation and study to give proper relay protection and selectivity. Thermal overload, differential, frequency, under-voltage, and current balance relays are given settings which depend only upon the device which they protect or system constants and hence, will not be dealt with here.

Realizing the necessity for a comprehensive short circuit and relay study, the problem was discussed with the consulting engineers, the equipment manufacturer, and the power company. As a result, it was decided that the analysis and setting of relays were the responsibility of Alan Wood. The equipment manufacturer offered to assist in making this study, recognizing its ultimate value.

The first requisite for the study was a complete single line diagram showing the 33 kv incoming lines, the turbo-generator, the entire 6900-volt system with all connected loads, all 33-kv and 6900-volt breakers, and all protective relays connected with these breakers. See Figure 7. In addition, the length, size of cable, type of cable, and type of enclosure for all conduit and duct runs were to be included along with the length, cable size and spacing of all pole and tower lines. It was also necessary to determine the impedances of all transformers shown on the single line diagram and the synchronous, transient, and subtransient reactances of all 6900-volt machines. And last, the maximum fault currents available from the Philadelphia Electric Co. lines had to be determined. These were obtained directly

Figure 4 — Control panel for blooming mill substations.



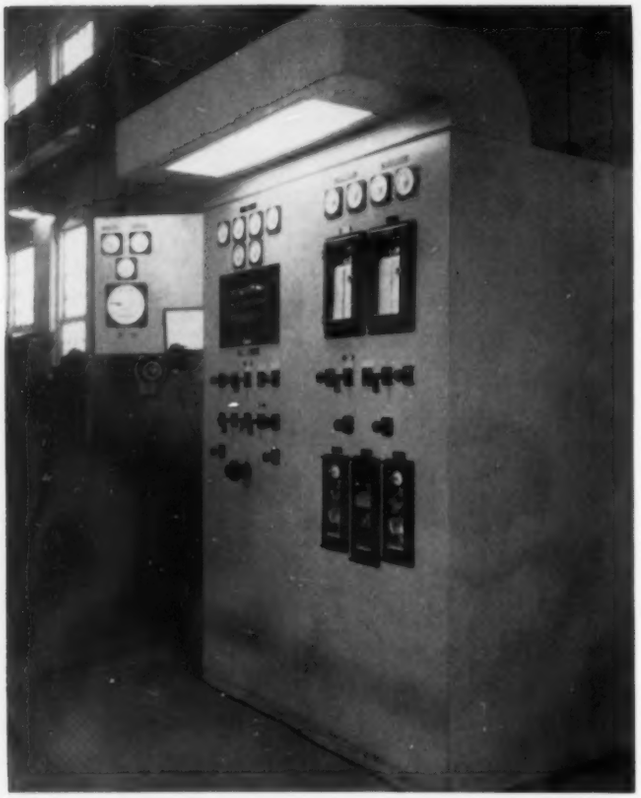


Figure 5 — Turbo-generator control panel at blast furnace. A radio communication system is in use between this point and blooming mill substation shown in Figure 4.

from the Philadelphia Electric Co. and from these values, the equivalent impedances representing the power company system, as seen by Alan Wood, were calculated.

In the Alan Wood system, there are four basic sources of short circuit current:

1. The new turbo-generator.
2. The power company incoming lines.
3. Synchronous motors.
4. Induction motors.

Strictly speaking, the power company incoming lines are generators but must be treated differently as will be explained later.

Generators will deliver short circuit current to a fault for an appreciable time since the generator prime mover will continue to drive the generator and the exciter will maintain the generator field.

Basically, synchronous motors have the same characteristics as generators in that they also have a d-c field and an a-c armature. Therefore, should a fault occur between the source of power and the synchronous motor, the inertia of its load will continue to drive the rotor and the motor becomes a generator delivering short circuit current to the fault.

Induction motors are considerably different. Here, no d-c field is present to cause generator action. However, an electric field, which is present during normal operation of the motor, does exist and simulates the effect of a d-c field in that it takes a few cycles for this field to decay after the power source has been removed. As in the case of the synchronous motor, the inertia of the load continues to drive the rotor of the induction motor, and the "stored" flux enables the motor to generate short circuit current for one or two cycles.

The magnitude of the short circuit currents delivered to a fault by these machines depends upon the sizes and internal impedances of the machines and the impedances of the circuits between the machines and the fault.

The amplitude of the alternating short circuit current generated by these machines decreases rapidly as shown in Figure 8. In the case of synchronous machines, the short circuit current decreases until it reaches a small steady state value. This is explained by the fact that the apparent internal reactance of the synchronous machines increases, and is accounted for in short circuit calculations by giving the internal reactance three distinct values, to be employed at different stages of the study. The first of these reactances is the subtransient reactance which applies for the first one or two cycles after the fault. Then the transient reactance becomes effective and applies for 30 or more cycles, depending upon the particular machine. After one or two seconds, the steady state is reached and the synchronous reactance is used. Generators having voltage regulators will produce greater steady state short circuit currents since the voltage regulator will put full field on the generator in its attempt to maintain rated voltage.

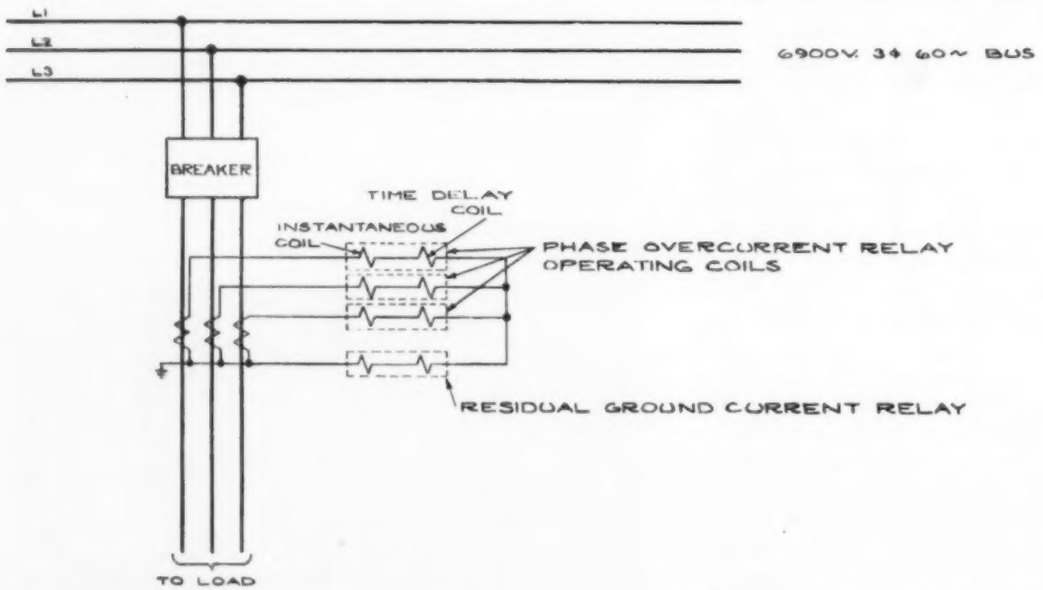


Figure 6 — Diagram shows connection for over-current relays.

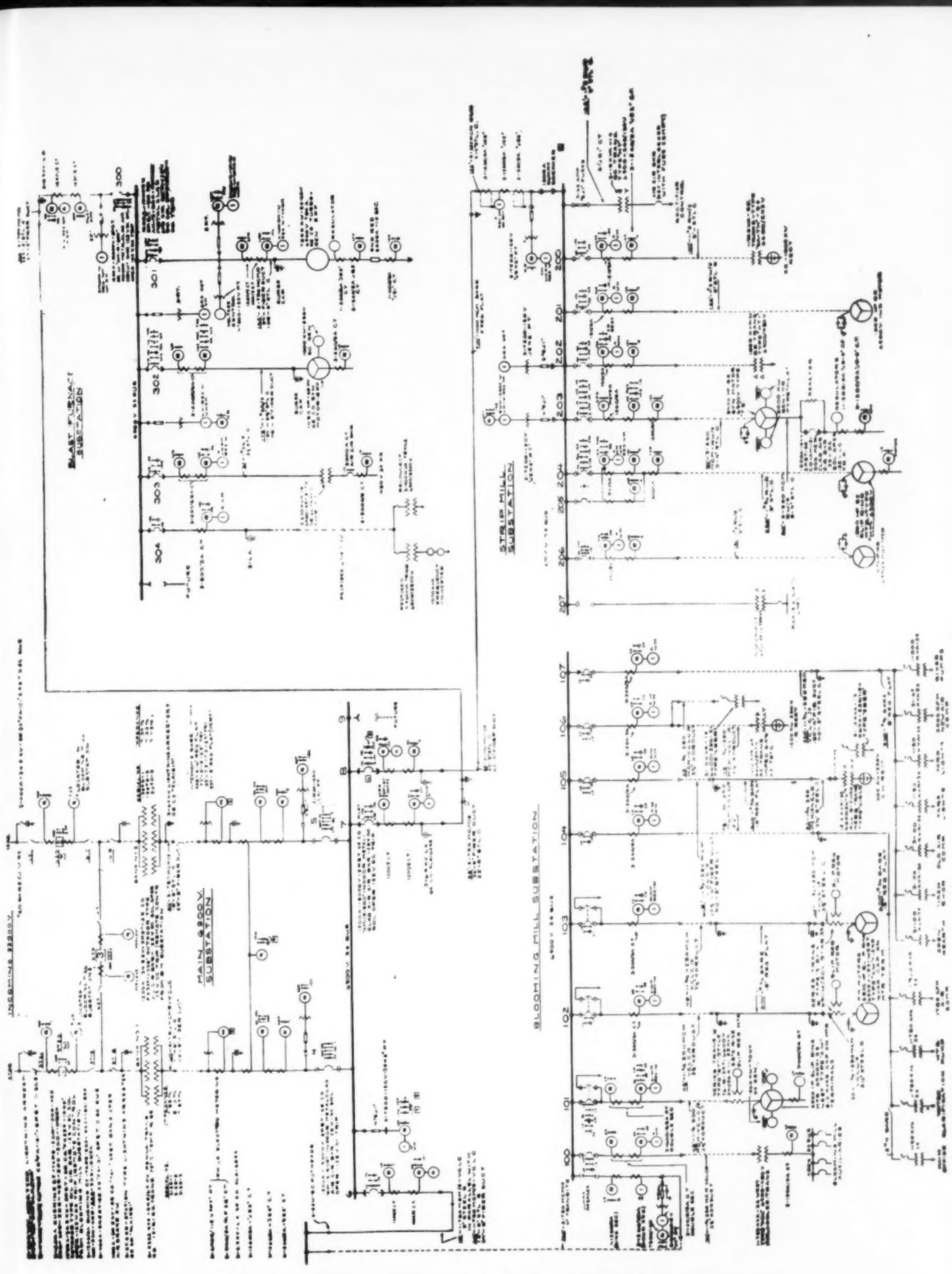


Figure 7 — Complete single line diagram shows entire 60-cycle system.

Because induction motors generate short circuit current only for the first cycle or so after the fault, they have only the subtransient reactance. Their transient and synchronous reactances are infinite.

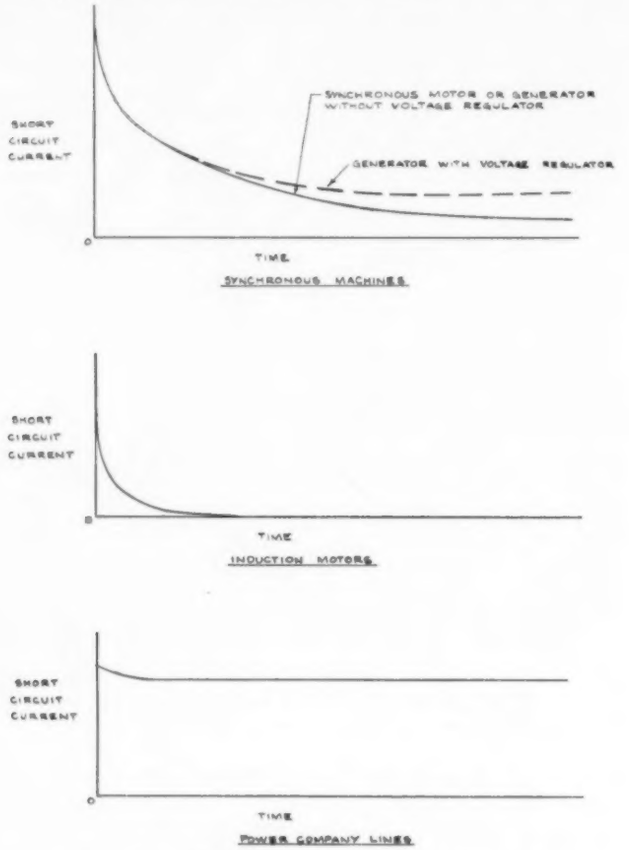


Figure 8 — Amplitude of short circuit current decreases rapidly as shown by the decrement curve.

In most cases, the power company short circuit contribution may be obtained from a single reactance since the tie line between the power company and the industrial plant has a relatively high reactance which tends to limit the short circuit current to the extent that any differences between the transient and subtransient reactances may be neglected. This is particularly true for faults on the lower voltage part of the system when power is purchased through transformer banks whose impedances add to that of the tie circuit.

The subtransient reactance alone does not describe the characteristics of the short circuit current output from a machine, because there may be some asymmetry of the wave form due to a d-c component, as shown in Figure 9. The magnitude of this component will depend on the instant at which the short circuit occurred, reaching a maximum in a given phase if the fault occurs when the voltage wave is going through zero. The d-c component disappears after the first few cycles. To account for this d-c component, standard practice is to multiply the subtransient reactance fault currents by a factor of 1.6, for systems above 5000 volts.

For industrial plants having no long transmission lines or underground conduit runs of appreciable length, the resistance of cables in the high voltage system may be ignored. When the spacing of the transmission lines, cable insulation, and conduit composition are known, the reactance of the cables may be obtained from appropriate handbook tables. These reactances may be considered as the impedances of their respective cables. The resistances of all high voltage machines may also be ignored, using their reactance to approximate their impedance. Transformer impedances are obtained directly from the transformer nameplate. On the low voltage (600 volts or less) system, the resistance of cables must be included in the cable impedance. It is permissible to neglect machine and transformer resistance as in the case of the high voltage system.

With all the data on hand, it must now be coordinated and put into a workable set of units. For this particular study, a base of 10,000 kva was chosen. Base current at 6900 volts is 837 amperes and base impedance is 4.76 ohms. Using the percentage method, any voltage, current, or impedance is then expressed as a percent of the base values. As an example, the per cent impedance of an element is equal to the impedance of the element times 100 and divided by the base impedance.

Now we come to the point of deciding just what we want out of the system study. First, we want to know what the fault current will be in all parts of the system immediately after a fault. This information will indicate whether or not the short-time current carrying capacity of the breakers will be exceeded by the most serious fault conditions. The subtransient reactances of the generators and motors are used in this part of the study, which will be called the momentary duty. The momentary duty fault currents must be multiplied by the factor of 1.6 to account for any possible asymmetry. Second, assuming the instantaneous relays act to trip the breaker, we want to know the magnitude of the fault currents that the breaker interrupts. Since the interruption occurs approximately eight cycles after the fault, the reactance of induction motors will be infinite here, while the transient reactance is used for synchronous motors. But, the subtransient reactance is again used for generators due to the fact that the fault current decays more slowly for generators than for

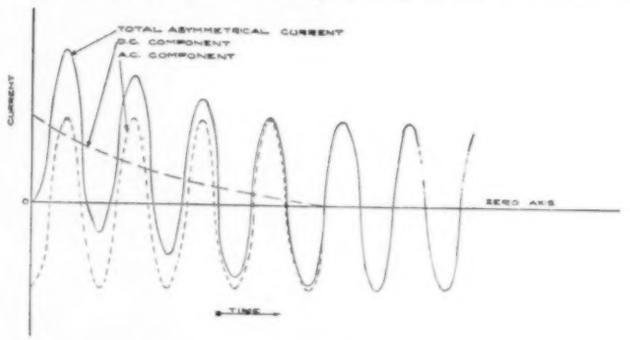


Figure 9 — Oscillogram shows decay of d-c component and effect of asymmetry current.

synchronous motors. In this case, the fault current may be assumed symmetrical. The information obtained from this part of the study tells whether or not the breakers are adequate to interrupt safely the fault currents for which they are responsible for interrupting. Lastly the fault current to which the time-delay relays react must be obtained. These currents start at once and continue for six or more cycles after the fault. Here, several combinations of reactance could be used but common practice is to use transient reactances for generators and synchronous motors, while infinite

reactance is used for induction motors. Again, the fault currents are assumed symmetrical.

Actually, momentary duty and interrupting duty do not enter into the selection of time-delay relay settings but are mentioned since they are obtained in the same manner as the relay duty and provide necessary and valuable data.

Normal operation of the Alan Wood system is with one Philadelphia electric company line and the turbo-generator. However, investigation must include every possible combination of the three power sources (the two Philadelphia electric company lines and the turbo-generator), since a fault could occur during switching as well as during normal operation. Faults must be assumed on all buses in order to obtain the information necessary to set all protective relays. Only three phase short circuits need be considered, since, with few exceptions, they produce the maximum fault current. Protective relays which have the same characteristics and are coordinated properly for maximum fault current, will be properly coordinated for the smaller fault currents.

And now the question arises as to how the system study is to be made. Even though the system under analysis is not too complex, calculation would be extremely lengthy. The alternate method of making this study is by using a system analyzer, which simulates the system in miniature.

For this study, a d-c analyzer was used which consists of a d-c generator having a base voltage of 100 volts and a base current of 10 milliamperes. There are 140 adjustable resistance units which may be given settings of 0 to 110 per cent resistance in one per cent steps. A milliammeter may be placed in any circuit by pressing the proper one of a series of pushbuttons. Very much simplified, the d-c analyzer is represented schematically in Figure 10. A 2 per cent resistance is provided between the positive terminal of the d-c generator and the generator bus to prevent shorting of the generator terminals. Connection of the system is made by means of telephone jacks. Thirty generator bus outlets are provided, which permits thirty sources of short circuit current in the system. Two ground jacks, which are connected to the negative side of the generator, enable the fault to be placed on any bus in the system.

Before the system was plugged into the analyzer,

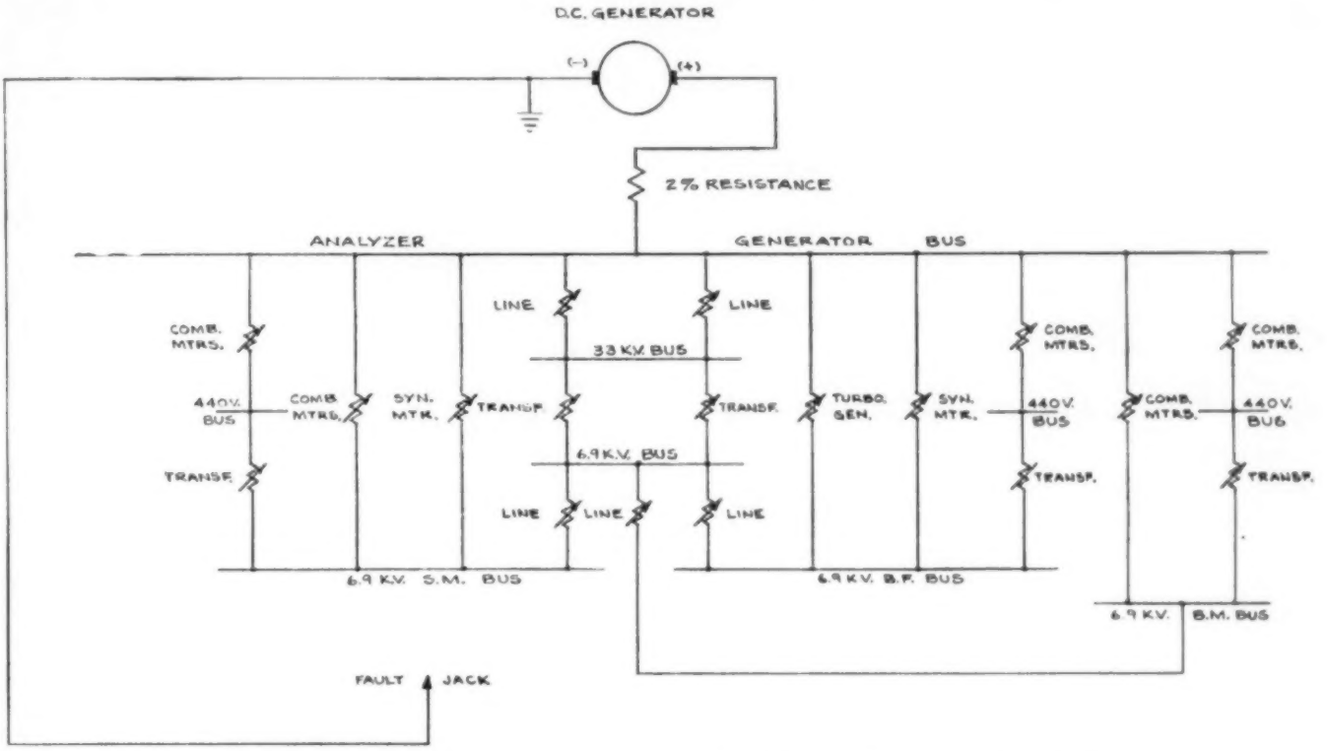


Figure 10 — Schematic diagram shows Alan Wood system plugged into d-c analyzer.

certain simplifications of the system diagram were made. The motor loads on each 440-volt bus were combined algebraically into one load and represented by one equivalent motor. The induction motor loads on each 6900-volt bus were combined also and represented by one equivalent motor. This reduces the system to that of Figure 11. The various reactances have been rounded off to figures which lend themselves readily to analyzer application. Loads which might be added in the near future were assumed and included in the circuit.

Each of the conditions mentioned previously, momentary duty, interrupting duty, and relay duty were successively plugged into the analyzer, using the corresponding values of subtransient or transient reactance. For each condition, all combinations of system power supply were considered. Faults were placed on every bus and the fault currents in each part of the circuit, as well as the total current at the fault, were read and recorded. The current readings were in per unit values (per cent divided by 100) and were converted to actual current values after the board study was completed.

As was expected, minimum fault currents were obtained when only the turbo-generator supply power to the system, while maximum fault currents occurred

when both power company lines and the turbo-generator all supplied power to the system.

After all possibilities of future system expansion had been considered and data taken, the board study was brought to a close. Now it remained to interpret the data taken and obtain settings for all of the systems instantaneous and time delay protective relays.

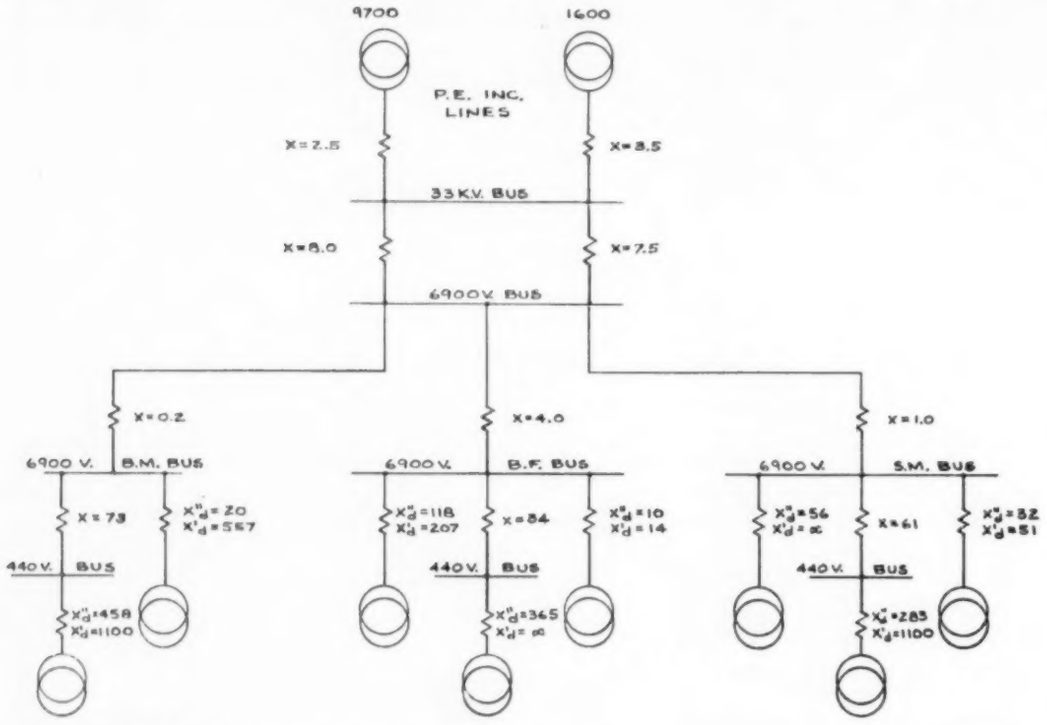
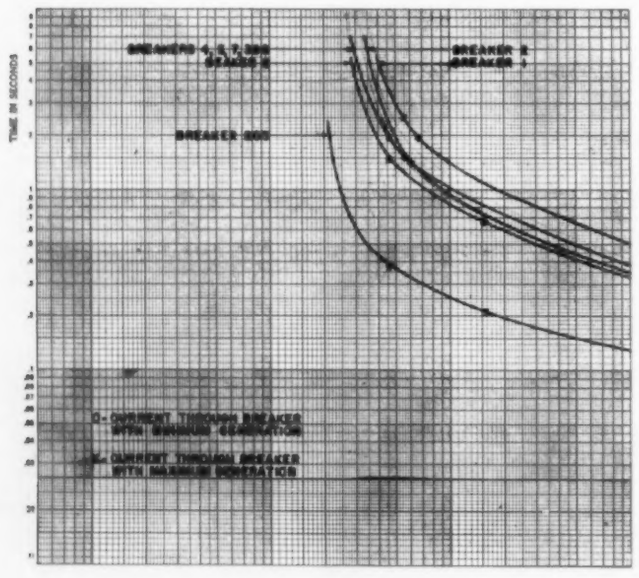


Figure 11—Sketch shows simplified system impedance diagram.

Before we discuss the methods used in determining settings for the instantaneous relays, we must decide how this relay is to protect the system. Referring to Figure 3, the individual feeder breakers such as at the blooming mill substation will be considered. Four types of loads are shown at this substation; motors, miscellaneous light and power feeders, transformers, and rectifiers. For motor loads, the instantaneous relay must not trip the feeder breaker for the maximum permissible starting currents nor should it trip the breaker due to the asymmetrical motor contribution to external faults, but it must trip the breaker for faults at the motor or on the motor feeder. Since the asymmetrical motor contribution to faults is equal to or greater than the maximum permissible starting currents, this value determines the setting of instantaneous relays protecting motor feeders. The instantaneous motor contribution to a fault is equal to the system base current times 100 and divided by the motor's subtransient reactance in per cent. The resulting factor is multiplied by 1.6 to obtain the asymmetrical value of fault current. The relay sees this current through a current transformer; therefore, the motor contribution is divided by the feeder current transformer ratio. These results may be tabulated as shown in Table I. The column entitled "Peak Load" contains the maximum permissible starting currents, while the column headed "Minimum Fault Current" lists the currents expected for a three-phase fault on, or close to, the blooming mill bus when the turbo-generator alone supplies power to the system. The relay is set at a value slightly above the motor contribution.

Figure 12 — Sample curves for 6900-volt fault on strip mill bus.



Miscellaneous light and power feeders offer a different type of problem. The various loads on such a feeder usually have individual fuse protection. Since it is almost impossible to coordinate instantaneous relays with fuses, we must rely upon the time delay relay alone to protect such circuits.

Transformers are dealt with rather easily by setting the instantaneous relay to ride over the initial magnetizing current inrush of the transformer. Operating practice has shown this value to be approximately 12 times normal full load current of the transformer. Again, the value thus obtained is referred to the current transformer secondary by dividing by the current transformer ratio. Then the setting of the instantaneous relay is chosen slightly above the magnetizing current inrush.

TABLE I

Sample Tabulation of Data for Setting Instantaneous Relays

Breaker No.	C. T. Ratio	Peak load		Motor contribution		Minimum fault current		Current setting
		Primary	Secondary	Primary	Secondary	Primary	Secondary	
100	100/5	753	38	....	....	6275	312	40
101	600/5	542	4.5	2350	19.6	6275	52.3	20
102	300/5	530	8.8	1555	30	6275	105	35
103	300/5	530	8.8	1555	30	6275	105	35
104	200/5	206	5.2	....	....	6275	157	..
105	200/5	1200	30	....	....	6275	157	30
106	200/5	1200	30	....	....	6275	157	30
107	200/5	181	4.5	....	....	6275	157	..

Since rectifiers are actually fed through transformers, the rectifier feeders are treated in the same manner as transformer feeders.

This completes the instantaneous relay part of the study. You may ask why instantaneous relays are not used on the main feeder breakers such as breakers No. 6, 7, and 8 of Figure 3. Instantaneous relays cannot be coordinated selectively except by their current settings and, with breakers in series, different current settings are possible only when there is sufficient impedance in the circuit between the two breakers to create a difference between the currents seen by the two breakers. In the average industrial plant, the length of the cables which make up the main bus feeders is not great enough to provide the impedance necessary.

The time delay relays used at Alan Wood are the inverse-time, induction type, overcurrent relays which have several fixed current taps and a time dial or lever. The current taps range from 0.5 to 2.0 amperes for ground relays, and 4 to 16 amperes for phase relays. The time dial is arbitrarily calibrated from 0 to 10. These relays have characteristic time-current curves of the same general shape which are supplied by the manufacturer. These curves along with the data gathered from the board study give the necessary information to set the time delay relays and obtain system selectivity.

In determining relay settings which will give system selectivity, two fundamental requirements must be met. First, two relays in series which have similarly shaped time-current characteristics and are selective for the maximum fault current will be selective for lesser fault currents, if the current setting of the slower relay, in terms of primary current, is equal to or exceeds the current setting of the faster relay, also in terms of primary current. Second, a time interval between relays in series must be allowed at the maximum fault current. In this study an interval of 0.4 second was used, made up of 0.13 second breaker opening time, 0.17 second factor of safety, and 0.1 second overtravel. The allowance for overtravel is necessary due to the fact that the inertia of the movable element to which the relay contact is attached continues to move for 0.1 second in the back up relay even though the fault has been removed.

Using the strip mill substation as an example for setting time delay relays and again referring to Figure 3, the breakers involved are the substation feeder breakers (No. 200 through No. 206) and the breakers which

TABLE II

Sample Tabulation of Data for Setting Time Delay Relays

Breaker No.	C. T. Ratio	Peak load		Fault current				Relay setting	
		Primary	Secondary	Minimum		Maximum		Current tap	Time dial
				Primary	Secondary	Primary	Secondary		
1	300/5	....	....	....	....	6,700	112	10	3.0
2	300/5	....	....	....	....	4,900	82	10	2
4	1200/5	1260	5.3	....	....	5,600	28	10	2
5	1200/5	1260	5.3	....	....	6,000	30	10	2
7-300	1200/5	750	3.1	4520	18.8	3,430	14.3	10	2.5
8	1200/5	1930	8.0	4520	18.8	15,700	65.5	10	2.0
203	1200/5	1650	6.9	4520	18.8	15,700	65.5	8	0.5

Note — All currents referred to 6300 volt base.

separate this substation from the various power supplies (Nos. 1, 2, 4, 5, 7, 8, and 300). Breakers No. 7 and No. 300 are at the opposite ends of the cross river transmission line and can be treated as one breaker since, if one breaker opens the other might as well open also. Rather than discuss all of the strip mill feeder breakers, only breaker No. 203 will be used in the example of selecting relay settings.

The data necessary to set the time delay relays is tabulated in Table II. The column "Peak Load" lists the maximum allowable sustained overload currents, such as a motor's maximum pullout torque current, a generator's rated short-time overload, or a transformer bank's permissible short-time overload. The column entitled "Minimum Fault Current" contains the values of fault current expected when the turbo-generator alone supplies power to the system, and the "Maximum Fault Current" column gives the fault current expected with both power company lines in use and the turbo-generator in service. The current tabulated is the current which flows through the breaker for a three phase fault on, or close to, the strip mill bus. These values were obtained by multiplying the per unit values from the board study data by the system base current of 837 amperes. The object now is to select settings for the time delay relays which will give selectivity for both maximum and minimum generation faults. Some breakers will not be subjected to fault current under the condition of minimum generation, in which case intermediate generation fault currents should be used to check selectivity.

The method used in obtaining these settings is to plot the characteristic curves of the individual relays on graph paper. This is done as follows:

1. An appropriate current scale is chosen which will cover the range of fault currents for all voltage levels referred to the 6900-volt base.
2. Starting at the farthest point from the power source, in this case the strip mill feeder breakers, the relay curves of the breakers are drawn in place. This is done by selecting a current tap setting which, when multiplied by the current transformer ratio, will put the curve in the range to include the two fault currents and yet clear the maximum load. Then a time dial setting must be selected which will permit the relay to trip the breaker as fast as possible. Again referring to Table II, the 8.0 ampere current tap was chosen for breaker No. 203. This value is the nearest larger current tap above the 6.9 ampere maximum load current. The minimum and maximum generation fault currents, in terms of the current transformer secondary, are both larger than the 8.0 ampere current tap, and hence, will be in the range of operation of the relay. The 0.5 second time dial setting was selected to give fast breaker tripping. This was repeated for all strip mill feeder breakers until all their curves had been drawn in place.
3. Going towards the source of power, the relay curve of the next breaker in series is then drawn in place, allowing the 0.4 second time interval mentioned previously at the maximum fault current. In this case, breaker No. 8 is next in series. The maximum load current may be obtained from the sum of the maximum load currents of the two largest motors on the strip mill bus which, when referred to the current transformer secondary, is 8.0 amperes. Thus, the 10 ampere current tap was selected. A time dial setting was then chosen which will give the 0.4 second time interval between breaker No. 203 and breaker No. 8 at the maximum fault current. Often it is not possible to obtain the exact 0.4 second interval, so a slightly larger interval is used. This procedure is repeated successively until the curve of the breaker nearest the source of power has been plotted, each time allowing a proper time interval. The resulting curves are shown in Figure 12. Note that the relay curves for breakers No. 4, 5, 7 and 300 coincide due to identical relay settings.

These steps were repeated for faults at each of the 6900-volt substations. It was necessary to consider several of the systems breakers repeatedly, since they serve as back up breakers for faults on all of system's 6900-volt buses. However, if the most heavily loaded bus is treated first, the settings obtained for the relays operating such breakers will usually give satisfactory selectivity for faults on the other system buses.

The relay operating the turbo-generator breaker must be handled differently. This particular relay is a time delay relay with voltage restraint. The ordinary time delay relay is not applicable here, since the permissible short time generator overload is often of the magnitude of short circuit currents which can be delivered by the generator. However, voltage restraint permits the time delay relay to ride over large currents as long as system voltage is maintained. Since a fault which is not cleared will cause the system voltage to decrease, the voltage restraint element which bucks the current element solves the problem of correctly tripping the generator breaker on fault currents only. The relay current tap is set at approximately 250 per cent generator full load current, referred to the current transformer secondary. In order to obtain the time dial setting, it is necessary to construct a short circuit decrement curve which shows the rate of decay of the generator fault current. The method used in constructing the decrement curve is presented in a paper entitled "Construction of Short Circuit Current Decrement Curves," by F. P. Brightman which was published in the July 1950 issue of *Power Engineering*. The resulting time versus effective current curve permits the selection of a time dial setting which will maintain the system selectivity thus far obtained.

The determination of settings for the ground relays is not as complex as it was for the phase relays. Here, only one source of ground current exists (the turbo-generator) and the maximum fault current is limited to 2000 amperes by the grounding resistor. The same procedure used in the case of phase relays was followed, selecting appropriate settings and plotting the relay characteristic curves in place. System selectivity was still the object with the turbo-generator breaker being the last to trip. The instantaneous attachments provided on the ground relays were set at their minimum operating values.

For the purpose of studying relay protection, 33 kv faults were divided into two groups — internal faults and external faults. Internal faults are those 33-kv faults which may occur within or close to, the Alan

Wood system. Referring to Figure 3, the breakers involved are No. 1, 2, 4, 5, 7, 300 and 301. Breakers No. 1 and No. 2 are backed up by Philadelphia Electric Co. breakers at the source end of the two incoming lines. The trip time of these breakers was obtained from the power company. At this point, settings for the relays operating the Alan Wood 33-kv breakers had already been chosen which would give selectivity for 6900-volt faults. However, it was necessary to repeat the procedure outlined previously to check selectivity for 33-kv faults.

External faults are those that may occur on the 33-kv incoming lines at some distance from Alan Wood. Due to the high circuit impedance, such faults would not draw sufficient short circuit current from the turbo-generator to operate the phase overcurrent relays which trip the breakers necessary to clear the fault. Consequently, a different type of protection must be used which will satisfy both the Philadelphia Electric Co. and the Alan Wood requirements.

The power company source breakers which control the incoming lines are not of the automatic reclosing type, but manual reclosing may occur as soon as one minute after a fault. Therefore, our turbo-generator must be off the line in less than one minute to prevent the possibility of the power company closing in out of synchronism with our turbo-generator.

The output of the turbo-generator is controlled by means of a load limitor which is manually set to carry a portion of the Alan Wood base load, depending upon the availability of blast furnace gas, while the power company supplies the additional power necessary to accommodate the balance. Circumstances are such that occasional dips in plant load cause small amounts of power to be delivered to the power company system. This also must be considered in protection against external faults.

Protection is obtained by means of three reverse power relays and an additional load limitor. One reverse power relay reacts to small amounts of power which may flow into the power company system and reduces the turbo-generator output by means of the load limitor. Should this reduction of power output from the turbo-generator not stop the reverse power flow, the other two reverse power relays will trip the transformer low side breakers (No. 4 and No. 5) in 30 seconds, removing Alan Wood from the Philadelphia Electric Co. system. Additional protection, against more serious external faults, is provided by means of an under-frequency relay which trips the same breakers when such a fault seriously overloads the turbo-generator and causes its frequency to decrease.

The load limitor and reverse power relay circuits are quite complex and could constitute a study in itself. We review it lightly here for it had a definite bearing on the overall system fault analysis.

This completed the relay study. All settings obtained were given to their respective relays. Subsequently it was found necessary to adjust the settings of two sets of instantaneous relays due to starting currents that were slightly higher than predicted.

The advantages gained by Alan Wood in making the relay study are numerous. Naturally, the objective of the study was attained — settings for the fault protective relays. But in the process, our single line diagram was developed to a point which gives the intimate details of the 60-cycle system. Also, complete understanding of system operation under fault conditions resulted along with a more complete understanding of fault protective relays and their application. Using the data from the board study, it was possible to face the problem of 33 kv external faults involving the turbo-generator load limiters and reverse power relays more comprehensively, and arrive at a solution which is practical. And last, information was obtained that will permit the setting of relays which may be included in the system due to future expansion.

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DISCUSSION

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H. H. Angel: I can not stress enough the importance of having, in the case of large users of electrical equipment, the relay engineers properly co-ordinate relay settings with the various persons involved, which might be the manufacturer of the equipment, the power company or others.

I know that once in a while circuits will trip out due solely to the lack of proper settings. It is mighty embarrassing for foremen to report such occurrences to superintendents; likewise superintendents feel the same in reporting trip outs or partial and complete shut downs to management, where proper analysis of the

condition pertaining to relay settings might have avoided this trouble.

Harold D. Ruger: Mr. Pinney's paper covered a phase of relay study and short-circuit study that I think every plant must eventually make. At Sparrows Point, we have two circuits carrying approximately 25,000 kw of power at 6900 volts from the sheet and tin mill substation to the 56-in. hot strip mill. This substation has four 10,000 kva transformers stepping the 34,500 volt service down to 6900 volts. One of these transformers developed leaks at the radiator flange gaskets. This transformer was taken out of service on a Sunday to make repairs. Monday morning the hot strip mill started up and had run only for a few hours when one of the two cables feeding it tripped off by residual or ground relay. The second cable then tripped by overload relay. This trouble had never been experienced before in the 15 years of the hot mill's operation. The circuits were both closed, the mill started up and after about three hours tripped again exactly the same as before. So, we went out to investigate the trouble. A check of residual relay current with a portable meter definitely proved that there was a residual current flowing and this current varied directly with the power current. This residual current normally should be zero unless there be a second ground on the system. We then realized the poor relay had only done its job. A further check revealed that there was no second ground on the system. So, we did what most steel men would do, I believe, set the relay up a little higher until we could find what was causing the trouble.

The manufacturer was called in to help make a study — the study revealed that the mutual coupling between the open power conductors in the flat configuration of phases ABC — ABC all on one crossarm was sufficient coupling in the 2000-ft run to cause an apparent residual current to flow. Steps have been taken to correct this configuration to our standard of ABC—CBA.

Robert T. Lucas: I believe everybody that has any power systems that amount to anything, must have a system study made. We had a lot of trouble with tripouts in our plant at Weirton. About five years ago it was necessary to increase the available power and we installed a 25,000-kva turbine, which we transmitted at 22,000 volts. Our existing circuits and generators were 6900, so we had to have a complete system survey made at that time. We do not operate in parallel with the power company, but we do take about a 50,000 demand from the power company. Our circuits operate independently and we are not tied in. So it is very imperative that we be able to clear the right circuits at the right time.

We have gone to pilot-relaying on all our circuits, with supervisory control from the power house to all breakers in our remote substations, except those that are feeding the separate buses.

I think when you get into these large magnitudes of current and power, a survey like this is absolutely necessary.

Frank P. Brightman: In the early part of his paper Mr. Pinney stated that, as the capacity of their power system and consequently its potential short-circuit capacity increased, they became increasingly aware of the need for making a relay coordination study. I would like to supplement that with the comment that small systems need attention in this respect just as much as large ones do. To be sure the high magnitudes of fault current encountered on large power systems can and usually do cause more damage than is done by the short circuit current on a small system. However, if maximum benefit is desired from the relay and circuit breaker equipment installed on a power system, it is just as necessary to make a relay coordination study of the small system as the large one. This is necessary because only by so doing can a faulted area be isolated with minimum damage to equipment and interruption of service to unfaulted equipment.

As pointed out in the paper, the usual practice when selecting time-current settings for the first one or two relays in a "chain" is to assume that the fault current from generators connected directly to the local plant bus is maintained at the initial transient reactance (X'_d) level. This practice is permissible because the error introduced is relatively minor. The error increases, however, as the operating time of the relay gets longer, because of the rapid and substantial decrease in the magnitude of fault current supplied by synchronous motors and generators as shown in Figure 8 of the paper. The initial fault current is high (8–15 times normal for industrial-plant-size turbine generators), but it drops to a steady-state value of 2.5–3 times normal in one or two seconds if there is a voltage regulator, and lower if there is no regulator. The error introduced by ignoring the effect of this decay can be tolerated on relays that work in approximately the first half second, but becomes undesirably large for slower relays in the "chain," because they operate on the low-magnitude portion of the fault current curve for a considerable portion of their total operating time. Obviously, relays will not operate at the same speed on the average current under the decrement curve, which is what they will actually "see," as they would on a current sustained at the initial level. Therefore, if we want the best performance from the system's protective relays, their time-current settings should be selected on the basis of the average current to which the relays are subjected during the period it takes them to close their contacts. In order to make an allowance for the decay in generator fault current, we must have a decrement curve showing the generator short-circuit current output based on the generator's voltage regulator increasing the field current up to the limit of ceiling-voltage imposed by good regulator operation. It is important that the decrement curve be based on this condition rather than on the commonly used method of assuming excitation maintained at full load value, because the additional excitation increases the generator steady-state fault current output about 75 per cent.

In a recent study I made, recognition of the generator decrement effect saved about 0.6 seconds of relay operating time. Naturally, one's first reaction is to think, "why worry about such a short space of time." The answer is, that while 0.6 seconds is often inconsequential, the additional damage done by leaving an electrical short-circuit on unnecessarily for 0.6 seconds might very well mean the difference between taking the damaged machine all apart to replace burned lamina-

tions as compared with installing a few new coils. In other words, the saving of a fraction of a second here, and another there, means less damage to equipment and loss of production, which is what relay systems are for. Such savings are the justification for making accurate relay studies.

Incidentally, many people are astonished at the fact that there is so little short circuit current so soon after the fault starts. This impression probably comes about because we are accustomed to thinking of fault currents in terms of the damage that high magnitude short circuit current does and naturally assume all fault currents must be of high magnitude. Actually, I think it is safe to say that current in the arc of a short circuit does a lot more damage than the same current would do it it was flowing "peacefully" in the circuit.

Although it may not be thought of as such, the electric power system is the heart of a steel plant just as it is of any industrial plant. No matter how many spare motors are installed, the plant will not be one whit more reliable than the power system supplying the motors that drive the machines. In like manner, a well laid out power distribution system with adequate circuit breakers is of limited value without proper relay equipment, since breakers alone cannot do their job of clearing faults unless they are "told" when to do it by something else. Relays and direct-acting trips are the "something else" that stand watch to detect short circuit trouble and give the "orders" to their respective breakers to open and confine the trouble quickly to as small an area as possible. In other words they are the brains of the power system. They are on the job all the time and do not take time out for lunch, etc. However, they are unable to think for themselves and have to be told when and what to do in the form of time and current settings. The relay coordination study that Mr. Pinney has just described provided that information for the Alan Wood Steel Co. power system.

That brings to mind that many users do not appreciate the fact that these time-current setting studies need to be made. Far too often it is taken for granted that, when equipment comes completely assembled from the switchgear factory, the relays and other adjustable short circuit protective devices are already correctly adjusted as part of the "package" deal. It should be clearly understood that such is not the case, and that the correct settings must be made after the equipment is installed. The proper time and current settings to be used have to be determined by a relay-coordination study such as that described by Mr. Pinney. Then the relays should be adjusted and tested with suitable equipment to make sure they will function as expected and required. It is particularly important that this relay testing operation include checking of the breaker tripping mechanism and control circuit, because experience indicates that trouble is more likely to exist or occur there than in the relays. Incidentally, while it is fairly common practice today for manufacturers to ship induction relays with the operating disk turned to the zero position so that the contacts are closed, thereby minimizing bouncing during transportation, sometimes relays are sent out with definite time-dial and tap settings. When this occurs it simply means that the relay time and current settings have been left in the positions they were in when the relay was tested as an individual device prior to assembly on the panel.

Now, granted that a relay coordination study should be made, comes the question of "who should make it." In our opinion, Alan Wood Co.'s experience confirms that it is very much to the users' advantage to make the study. By so doing they will benefit in the following ways:

1. They will acquire a far better understanding of the details of the power system layout and its protective equipment than is likely to be acquired in any other manner.
2. They will understand why a given relay is set as it is. Then when a breaker trips for no readily discernable reason they will be inclined to search diligently for the cause of the tripping, rather than assume that someone had made an error. Too often this assumption results in the suspected error being corrected by increasing the time or current setting, or both, and in so doing weakening or entirely destroying the effectiveness of the relay protection.
3. The fact that the users' engineering department people are making the survey and study is quite likely to result in closer understanding and contact between the engineering and operating staffs. Then, when the operators cannot account for a breaker's tripping, they are more likely to consult with the engineers instead of arbitrarily deciding on their own account to "fix that thing so it won't bother me any more." Too often the latter variety of "fixing" means increasing the setting to the point where the protective device would be more or less useless.

Alan Wood Co.'s experience also confirms our belief that a manufacturer is doing his customer a greater service by showing him how to do the study himself than by doing it for him. Assuming that the user's engineers are normal people who had had a study made for them, they would very likely have done as most busy people do, namely:

1. Have the relays set in accordance with the suggested time-current settings in the Report of the Coordination Study, meantime hoping that the individual who made the study knew what he was doing and that the settings were right.
2. Lay the report aside to be studied at some more convenient period when there is more time.

As many of us have learned from experience, that more opportune moment never seems to arrive and the report never gets studied. Consequently the user's engineers do not have an intimate knowledge of the system or the reasons for the individual relay adjustments. Therefore when a relay trips a circuit breaker for no readily apparent reason, there is a strong inclination to mistrust the accuracy of the settings contained in a report made by someone else. The usual result is that the relay settings are arbitrarily increased in current or time, or both, with the inevitable result that the protection is reduced or in extreme cases destroyed altogether, because the setting gets so high that the device cannot function on the current available. The incident described as follows which occurred very shortly

after the relays had been set in accordance with the time-current values determined from Mr. Pinney's study, confirmed the value to the Alan Wood people of having done the study themselves.

The primary breaker of a pumped-tank rectifier tripped instantly for no apparent reason when the operator closed it. Being unable to find anything wrong the operator tried it again with the same result. Then came the payoff — the operator, knowing that his own engineering department had been making a study of the relay settings on the system, reported the incident to the engineers and asked for instructions as to what to do with the relay. In the normal course of events prior to making of the study, the operator might have been inclined to "fix that blamed relay" by increasing the settings arbitrarily, so that it wouldn't bother him any more. Subsequent investigation revealed that the relay was tripping the breaker due to short-circuit currents created by arc backs in the rectifier tanks. The arc backs were due to insufficient vacuum and low tank temperature following a repair job. The first, and quite normal inclination, to set the relay higher, might very well have proven "fatal" to the rectifier tanks and the transformer, both of which are easily damaged by repeated or prolonged arc backs.

Another advantage resulting from the user's doing the study with the manufacturer's guidance benefits the industry as a whole. This comes about, because a manufacturer's engineer can guide and direct several user-studies in the same time that would be required for him to do all the work on one study. This is important, because there are a great many industrial plants needing such studies initially, not to mention subsequent studies when system changes are made. Such cooperative endeavor is to the advantage of all concerned because it insures that the carefully designed short circuit protection system the user paid for will have an opportunity to prove its value.

W. W. Ware: This relay study is something that any electrical engineer could do — that is, you do not need any special training. As Mr. Brightman has said, there is a tremendous amount of leg work involved in a relay study of this kind. If we, in the Philadelphia Electric Co. had done the relay study for Alan Wood, it would have taken as long if not longer, because we do not know too much about the steel business, and do not know what is expected from the relays in the steel plant. Alan Wood knows what they want and with just a little bit of digging into text books and with help from people who know something of relays, they can come up with an even better job than the Philadelphia Electric Co. could.

If we tackled all the relay problems for customers, we probably would require ten times as many men on our relay staff, and it would cost the customer just as much money in the end, anyway, because we would be spending half of our time in the customer's plant, taking time to learn how he intended to use his electric system. After all, you know your plant, and you know what you want to get out of it. It is true in relaying a plant — you take an old plant that has grown — a little goes off here and a little over there as the plant is expanding and before long it gets out of hand so that it cannot relay properly. By using a little bit of judgment as the plant expands, you can make it possible to relay properly so that only a faulty piece of equipment will be lost.

Another thing, Mr. Brightman mentioned 36 cycles as being a long time. That really is the truth, since in six-tenths of a second severe fault current can do a lot of damage.

For instance, on our own system we had a fault, the short circuit current for which was comparable to the magnitude of currents that Mr. Pinney came up with in the Alan Wood Steel study. When the fault occurred, the line tripped off in the proper length of time, which is as fast as we dared take it off, since we have to relay our system so that the customers will have relay time left for themselves. One of the men in our special investigating department asked what happened to the relays. Blaming relays is the first thing they think of. He said that two feet of the cable disappeared including part of the current transformer which was adjacent to it. He was placated somewhat when he learned that the current was five thousand amperes and a second was required to clear the fault. He said that he thought we had fast clearing for such faults, but I explained that 60 cycles was as fast as we dared clear that line if time is to be left for our customers. In other words, for a customer similar to Alan Wood any fault within the plant should be cleared within 35 cycles for proper relaying. This does not sound like a lot of time but you will find you can do a tremendous amount of relaying within the 35 cycles.

Mr. Pinney started with what seemed an impossible situation, but by careful study, ended with an excellent relay protection scheme for which he is to be congratulated.

P. G. Gilbert: It has been my observation that all too frequently, some users have expended substantial sums of money to get the best in available relay equipment, and then through a failure to make such a study, have not realized all of the protective potentialities they had.

The art of protective relaying has developed to a point where protection can be afforded for almost any fault that could be reasonably expected to occur, and do this with a minimum disturbance to the system.

The protective relays of today represent the product of a lot of thought and research by engineers and scientists and accumulated experience of years. Some are extremely ingenious. All are made with precision. The result is of necessity costly unless it be a relay where wide usage makes quantity production a possibility. When the possible savings in the loss of production and damage to costly apparatus is considered, they represent a very prudent investment.

The proper application of these relays is, of course, of first importance. Beyond this, however, the relays must be given the proper setting. This usually means routine but tedious calculations have to be made, or a study made on a calculating board. The d-c board is quite adequate for that purpose.

The decision to change to 60 cycles, made at the time the blooming mill installation went in, seemed to follow the pattern of most steel industries who started out with 25-cycle systems, generating their own power.

Today it is doubtful if steel companies can econom-

ically justify generating more of their power requirements than would be available from the blast furnace gases. Except for a few old 25-cycle installations, the electric utilities are not usually prepared to offer prime 25-cycle power. The cost of frequency conversion equipment, plus the higher cost of all 25-cycle apparatus, makes the decision a natural one.

The decision to ground the 6900-volt system also accords with the prevailing practice. So much has been written lately on the subject of the advantages to be gained by grounding that no repetition will be included in these comments. The installation of the 7500-kw turbogenerator offered a natural source of controlled ground fault current.

It is noted that it is the only source of ground fault current, so that without it the system would be ungrounded. It would appear that other factors favor the continuous operation of the generator.

While I do not find reference to it in the paper, the single line diagram seemed to indicate that pilot wire relaying is used at least on one of the lines between the main transformer substation and the blast furnace station, Figure 7.

I would expect that as the 60-cycle system expands, an increasing use of this type of relaying would be favored. This type of relaying has been a boon to the steel and other heavy industries with extensive power distribution systems. In fact, a stage is approached on such a system where the factors of time and direction control no longer will suffice, and the pilot wire relay appears to be the only answer.

When we consider that for both phase and ground faults, with one relay per terminal and using current only, one cycle of relaying time is all that is required for clearing differentially the two ends of a tie line, these relays truly come in the category of ingenious devices and their introduction represented a noteworthy engineering achievement.

Fortunately, even should it be found desirable at a later date to speed the clearing of tie lines with this type of relaying, nothing would be lost in the original investment, as it is usual practice to back up a pilot wire relaying with the slower speed induction type relays.

C. L. Eichenberg: Mr. Pinney has presented a very interesting treatise on the problems he encountered in developing an effective scheme of relaying for the Alan Wood power system. Although this system is not very complex, it was found advantageous to make an analysis of short circuit currents by means of the d-c calculating board, and we are sure that the results obtained justified the expenditures involved.

The best relaying system is only as good as the quality of the maintenance it receives. Periodic testing and calibration of the relays is an absolute necessity, if they are to perform according to the relay engineer's calculations. This testing is the only assurance one has that a fault will be cleared without shutting down equipment unnecessarily.

Mr. Pinney has pointed out the advantages obtained by selective coordination of relay settings. Whenever a system grows in complexity and the number of cascaded breakers increases, the fault clearing times of the breakers closest to the source become so long that the damage caused by the fault becomes excessive. Also, longer relaying times often permit fault currents to exceed the short time rating of interconnecting cables. The obvious answer to such a condition is the application of pilot wire differential relaying for the protection of lines and high speed bus differential relaying for the protection of switchgear and bus. The time-overcurrent relays discussed in this paper are then relegated to the position of back-up protection, although their importance should not be minimized. Occasionally, it is possible to apply directional time-overcurrent relays instead of straight over-current relays for protection of line sections in which power can flow both ways. This results in a reduction in tripping time for cascaded breakers and improves the selectivity. We are sure that the Alan Wood system has certain line sections protected by such relays.

In the application of ground relays to utilization equipment, Mr. Pinney states that the instantaneous attachments are set at their lowest value. We do not understand how instantaneous ground relay protection can be applied to a system of limited ground current, since the relays must be set high enough to ride over any unequal reproduction of the current transformers during a heavy inrush and the limited ground current available, would in many instances, be insufficient to operate the instantaneous relay under fault conditions. We feel that short-time induction time-overcurrent relays provide the best solution to sensitive ground fault protection which will not operate falsely on inrush currents and yet will remove a ground fault in a minimum of time.

We understand that the source of ground current is secured from the 7500-kw turbine. When the turbine is out of service for inspection, does the system operate with an ungrounded neutral, or is there another source of neutral grounding provided?

We were also very much interested in Mr. Pinney's experience in arriving at a setting for the voltage restraint overcurrent relays applied to the turbine generator. We made similar calculations for an application in the Bethlehem plant seven years ago, and seven additional applications three years ago. In the Bethlehem application these relays are used purely as backup protection, as the last resort to remove generation in case a feeder breaker fails to trip or the failure of bus differential relays to operate during a bus fault.

James A. B. Pinney: With reference to Mr. Eichenberg's comment concerning the instantaneous attachment on ground relays, perhaps I should have stated that such relays are not used in back-up or main distribution breakers, but only on those breakers which feed their own distinct loads. We feel that any unequal reproduction of the current transformers during a permissible inrush would still not be large enough to cause false tripping, and that any instantaneous ground relay tripping would be due either to ground faults or unequal current transformer reproduction of phase faults.

In reply to Mr. Eichenberg's question relative to the grounding of our system, the turbine provides our only source of neutral grounding at 6900 volts. When the turbine is removed from the line, the 6900-volt system operates ungrounded.

ELECTRIC FURNACE VS. OPEN HEARTH IN COLD METAL SHOPS

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. . . . taken from a paper presented at Philadelphia Regional Technical Meeting of American Iron and Steel Institute, December 3, 1953 . . . .

▲ ALMOST all the open hearth steel made in this country is made in basic lined furnaces, so that a basic slag can be carried for the removal of phosphorus and sulphur. The relatively few acid furnaces are of small size and are mostly used for the production of steel castings and not for ingots. Although the preponderance of basic over acid linings in electric furnaces is not as great as in open hearths, the large electric furnaces offering possible competition with the open hearths in the production of soft steel for ingots are all basic lined. So, in this respect the two processes are identical.

Most open hearth steel is made in large integrated steel plants where hot metal direct from the blast furnaces is available for part of the open hearth charge. This hot metal greatly increases the production from open hearth furnaces, since part of the charge is already molten when charged, and charging time is reduced, as molten metal can be added faster from a ladle than the same weight of cold metal can be added in charging pans. Experimental hot metal heats have been successfully made in electric furnaces, but current practice is with an all-cold charge. The refining of pig iron into steel is essentially an oxidation process and the open hearth is inherently more oxidizing than the electric furnace, so the open hearth requires more pig iron or hot metal in the charge than the electric furnace, and can handle relatively large quantities to better advantage without excessive ore additions. It is doubtful if hot metal charges will ever produce as much benefit in the electric furnace as is obtainable in the open hearth, and this paper will be limited to cold metal shops.

FUEL

The basic difference between the open hearth and the electric furnace is the source of heat energy. The open hearth furnace is heated by the combustion of liquid or gaseous fuel with preheated air. The theoretical flame temperature of commercially available fuels with cold air is little if any above steelmaking temperatures, and with some fuels is actually below. The invention of regenerators by Siemens in 1868 first made steel melting temperatures obtainable by direct combustion. These regenerators absorb heat from the waste gases leaving the furnace, and return it to the combustion air through a system of reverse valves. Air preheat temperatures of 1500 to 1600 F are obtainable by this method, so flame temperatures well above steel melting temperature and even beyond the limit of available refractories, can be obtained. Heat transfer from the flame to the bath is mainly by radiation, although some convection heat transfer occurs, particularly during the early part of the meltdown. Radiation from this high temperature flame also strikes the roof and sidewalls and the softening point of the furnace lining imposes a limit on the heat release rate in the furnace, and consequently on the production rate.

In the electric furnace the heat is released in an arc between the electrode and the bath. The limitation on heat release is primarily the ability of the bath to conduct heat away from the points of release and distribute it uniformly throughout the bath. Although radiation occurs from the high temperature arc to the furnace lining, the arcs are so small that the distribution of heat between bath and furnace lining is much more favorable in the electric furnace than in the open hearth.

The heat absorbed by the bath for heating and melting the charge, bath reactions, and slag formation, is about 1,400,000 Btu per ton of steel for an all-cold pig and scrap charge. The usual fuel requirements of an open hearth furnace on this charge are about 4,500,000 Btu, or an overall efficiency of about 31 per cent. About 33 per cent of the heat in the fuel is lost in the stack gases and about 36 per cent is absorbed by

cooling water and lost by radiation from the furnace walls. In some cases waste heat boilers are installed and part of the heat in the stack gases is recovered and converted into steam, giving a credit to the fuel charged to the furnace.

Open hearth furnaces are fired with residual fuel oil, tar, coke oven gas or natural gas or combinations of these. Tar and coke oven gas are only available in integrated steel plants where hot metal is also available for the open hearth charge. Natural gas is only available at competitive prices in favored sections of the country. In this comparison residual fuel oil will be considered the standard open hearth fuel. The price of fuel oil varies greatly, depending on the distance from the oil refinery. A price of 9¢ per gal, equivalent to 60¢ per million Btu, will be used. This is considerably higher than the current price at the refinery and lower than the price in unfavorable locations. It is not an average price, but is believed to be a fair price for this comparison, since the location of the plants under discussion will be determined more by the market available and the supply of other raw materials than by cheap fuel. At 60¢ per million Btu the fuel cost of 4,500,000 Btu is $2.70 per ton of steel.

In contrast with low fuel efficiency and cheap fuel in the open hearth, the electric furnace is characterized by high efficiency and expensive energy. The larger electric furnaces, of sizes competitive with the open hearth in melting soft steel, require about 530 kwhr per per ton of steel. This is equivalent to 1,800,000 Btu. With 1,400,000 Btu absorbed by the bath, this is an overall efficiency of 78 per cent, or 2.5 times the 31 per cent efficiency of the open hearth. Although there is some variation in the price of electric energy in different locations, it is much less variable than fuel oil. A price of 9 mills per kwhr is fairly representative of the cost to steel plants. This is equivalent to $2.64 per million Btu, or 4.4 times the price of fuel oil. At 1,800,000 Btu per ton of steel the cost of electric energy is $4.75 per ton, or 75 per cent higher than the $2.70 open hearth cost. The high efficiency of the electric furnace compensates for much, but not all, of the high price of electric energy.

MATERIAL HANDLING

With the high production rates of modern steel melting furnaces, one of the major operating problems is the handling of materials to and from the furnace. All open hearth furnaces are side charged through three or more doors in the front wall. The size of charging pans which can go through the doors and the capacity of the charging machines limit the charge per pan, which is usually less than 2 tons, requiring over 100 pans for a 200-ton heat and a charging time of three hours or more. In addition, the long drags of charging buggies required, frequently interfere with the operation of furnaces adjacent to the one being charged. Several designs for top-charged open hearths have been worked out on paper but none is in successful operation. The electric furnace may be either side or top charged or both. The side charged electric furnace has the same disadvantages as the open hearth. For top charging, the roof may be either swung to one side of the furnace or may be lifted off and carried out of the way by a gantry crane. Both of these methods of roof removal are in successful operation, with the swing type predominant. The charge is added in a large drop bottom bucket lowered through the roof opening, and frequently the entire charging operation can be completed in 5 to 10 minutes.

All electric furnaces are tilters. A few tilting open hearth furnaces are in operation but most of them are stationary. The tilting open hearth involves serious construction difficulties at the joint between the tilting hearth and the stationary port ends, with considerable increase in construction and maintenance costs. Any tilting furnace permits a shorter tap hole, requiring little attention and repair, and hard taps are avoided. In general, the electric furnace has some advantages over the open hearth in getting material into and out of the furnace.

STEEL QUALITY

The electric furnace has an established reputation for the manufacture of high quality alloy steel, most of which is made with two-slag practice. For plain carbon steel with a single slag, the quality of electric furnace steel is as good as, or better than, open hearth steel made from the same charge. In usual practice, the open hearth charge will carry a higher proportion of virgin pig iron and a lower proportion of scrap than the electric furnace. Much of the scrap currently available contains appreciable amounts of so called "tramp" metals, such as copper, nickel, chromium, and molybdenum, which are useful alloys in various alloy steels; and lead, tin, arsenic, and antimony, which remain in the scrap as the result of poor scrap preparation. These elements are detrimental to steel quality in varying degree, particularly in soft steel for welding, deep drawing, and cold forming applications, where the alloying elements have a hardening effect. Due to the higher proportion of scrap in electric furnace steel, this injurious effect is more pronounced than in open hearth steel.

With the exception of natural gas, all open hearth fuels contain appreciable amounts of sulphur. Residual fuel oil, frequently contains 1 per cent or more, and is the major source of sulphur in the open hearth and much greater than the sulphur introduced in the charge. In the electric furnace, the only sulphur introduced is that contained in the charge. Sulphur removal is facilitated by higher temperatures and more basic slags. Higher temperatures are more easily obtained in the electric than in the open hearth furnace. More basic slags result in more slag volume and more viscous slags, which retard the flow of heat and oxygen from the flame to the metal, with a decrease in open hearth production. In the electric furnace the heat is released at the metal surface and a highly basic slag is not so detrimental. In general, the control of sulphur in the electric furnace is much more satisfactory than in the open hearth, because less sulphur is introduced and the conditions for its removal are more easily obtained.

The removal of carbon, manganese, silicon, and phosphorus is largely a matter of control of temperature and furnace atmosphere, except for phosphorus which also requires a basic slag. Temperature control is much more satisfactory in the electric furnace than in the

open hearth. The temperature of the arc, about 6000 F, is much above steelmaking temperature, and the problem is to limit the temperature, while in the open hearth it is frequently a problem to get enough temperature through the slag into the metal without damaging the brickwork. The large mass of brickwork in the open hearth furnace system stores immense quantities of heat, causing a time lag in response to adjustments for changes in temperature. In the electric furnace the response to temperature adjustments is almost immediate. In general, the electric furnace gives better control for the removal of the common impurities in steel than the open hearth furnace does.

ECONOMIC CONSIDERATIONS

Even though a steel melting process may be technically and metallurgically sound, it is not necessarily competitive with alternative processes. The cost factors involved in an economic comparison of electric and open hearth furnaces will be discussed under the following subdivisions: (1) operating costs, (2) material costs, (3) installation costs and capital charges, and (4) total ingot costs. The cost of producing steel is affected by the size of the plant and the size of the melting furnaces. A steel plant with a capacity of 250,000 tons per year is about the smallest which can be competitive. For a capacity about 500,000 tons per year, an integrated steel plant with one or more blast furnaces to supply hot metal is indicated. Cost comparisons between electric and open hearth furnaces will be made for plants of 250,000 tons and 500,000 tons per year which cover the range in which the electric furnace has the best chance to compete with the open hearth.

Three furnaces are about the minimum which can be operated satisfactorily in order to have flexibility of operation, and in the case of electric furnaces, in order to reduce surges and power demand charges. A modern 150-ton open hearth furnace will produce about 11 tons per hour of plain carbon steel ingots on a cold metal charge. About 8 per cent down time will be required for furnace repairs and rebuilds, giving a furnace availability of 92 per cent. Each furnace will produce 11 tons per hour, times 24 hours per day, times 360 days per year, times 92 per cent availability, equals 87,500 tons per year, or 262,500 tons for three furnaces. A 16-ft diameter electric furnace with 15,000 kva transformers will also produce about 11 tons of soft steel ingots per hour. The furnace availability will be higher, about 95 per cent, and the production per furnace per year will be $11 \times 24 \times 360 \times 0.95 = 90{,}200$ tons per furnace, or 270,000 tons per year from three furnaces.

For the 500,000-ton shop, larger furnaces can be used with resulting economies in operation and no loss in flexibility. A 225-ton open hearth furnace will produce about 16.5 tons per hour, or $16.5 \times 24 \times 360 \times 0.92 =$

TABLE I

Operating Cost Per Ton Ingots

Annual Capacity of Plant	250,000 Tons		500,000 Tons	
Type of Furnace	Open Hearth	Electric	Open Hearth	Electric
Number and size of furnaces	3—150 T.	3—60 T.	4—225 T.	4—90 T.
Tons per furnace hour	11.0	11.0	16.5	17.0
MM Btu or kwhr per ton	4.8	500	4.2	500
Operating labor	$2.20	$1.80	$1.80	$1.45
Repair labor and material	1.00	1.00	0.80	0.80
Fuel or power	2.78	4.95	2.52	4.50
Electrodes	.....	2.40	.....	2.40
Supplies	0.40	0.40	0.40	0.40
Water, steam, power, etc.	0.50	0.50	0.50	0.50
Switching and locomotive cranes	0.65	0.70	0.60	0.65
Overhead and misc.	0.60	0.80	0.50	0.70
Furnace repairs	1.80	1.50	1.60	1.30
Molds, stools and pans	1.00	1.00	1.00	1.00
Total operating cost	$10.93	$15.05	$ 9.72	$13.70

TABLE II

Material Cost Per Ton of Ingots

Type of furnace		Open Hearth	Electric
Per cent iron in charge		30	8
Per cent scrap in charge		70	92
Per cent yield		89	92
Lb pig iron per net ton ingots		674	174
Lb scrap per net ton ingots		1572	2000
Lb ore per net ton ingots		40	40
Lb burnt lime per net ton ingots		80	80
Lb ferroalloys per net ton ingots		12	12
Lb furnace refractories per net ton ingots		80	60
Pig iron	@ $ 56.00 gross ton	$16.82	$ 4.35
Scrap	@ $ 43.00 gross ton	30.80	38.40
Ore	@ $ 18.00 gross ton	0.36	0.36
Burnt lime	@ $ 16.00 net ton	0.64	0.64
Ferroalloys	@ $210.00 net ton	1.14	1.14
Furnace refractories	@ $ 18.00 net ton	0.72	0.54
Total material cost		$49.48	$45.43

TABLE IIA

Material Cost With Cheap Scrap

Type of furnace		Open hearth	Electric
Pig iron	@ $ 56.00 gross ton	$16.82	$ 4.35
Scrap	@ $ 20.00 gross ton	14.04	17.88
Ore	@ $ 18.00 gross ton	0.36	0.36
Burnt lime	@ $ 16.00 net ton	0.64	0.64
Ferroalloys	@ $210.00 net ton	1.14	1.14
Furnace refractories	@ $ 18.00 net ton	0.72	0.54
Total material cost		$33.72	$24.91

TABLE IIB

Material Cost With Cheap Pig Iron

Type of Furnace		Open hearth	Electric
Pig iron	@ $ 36.00 gross ton	$10.81	$ 2.80
Scrap	@ $ 43.00 gross ton	30.80	38.40
Ore	@ $ 18.00 gross ton	0.36	0.36
Burnt lime	@ $ 16.00 net ton	0.64	0.64
Ferroalloys	@ $210.00 net ton	1.14	1.14
Furnace refractories	@ $ 18.00 net ton	0.72	0.54
Total material cost		$44.47	$43.88

131,000 tons of ingots per year. Four such furnaces will have a production of 524,000 tons per year. A 20-ft diameter electric furnace with 25,000 kva transformers will produce about 17 tons per hour or 17 × 24 × 360 × 0.95 = 140,000 tons per year. Four such furnaces would produce 560,000 tons of ingots per year. The figures used above for tons per hour have been reached and exceeded in modern shops. Old shops frequently have inherent handicaps which prevent getting full production from the furnaces, and no attempt was made to get average figures. The figures used are conservative and well within reach in plants using up-to-date practices.

OPERATING COSTS

The operating costs for the two sizes of plants and the two types of furnaces under consideration are shown in Table I. Operating costs vary considerably from plant to plant. The figures tabulated are not those of any one plant but are typical of what may be expected in fairly modern plants. These figures are based on labor at $2.20 per hour, fuel oil at $0.60 per million Btu, electric power at 9 mills per kwhr, and electrodes at $0.19 per pound. These figures show about $1.25 per ton lower operating cost in the large than in the small plants, primarily due to lower labor, fuel and repairs with the larger furnaces. The open hearth operating cost is about $4.00 per ton lower than the electric, due to cheaper fuel and the high cost of electrodes in the electric furnaces. Many open hearth furnaces are in operation with fuel costs lower than the cost of electrodes in electric furnaces.

MATERIAL COSTS

Table II shows the material costs for the two types of furnaces. This table is based on a charge of 30 per cent iron, 70 per cent scrap, and 89 per cent yield for the open hearth; and a charge of 8 per cent iron, 92 per cent scrap, and 92 per cent yield for the electric furnace. The prices used are 1953 prices in the Pittsburgh district. Purchased pig iron at $56.00 per gross ton is $13.00 per ton higher than No. 2 heavy melting scrap at $43.00 per gross ton, and this penalizes the open hearth with its higher percentage of pig iron in the charge. The open hearth material cost is $4.05 per ton higher than the electric furnace, practically all of which is in the high cost of pig iron.

The price of scrap varies greatly at different times and places. In July 1953 scrap was $20.00 per gross ton at Los Angeles and as recently as July 1949 it was $20.00 per ton in Pittsburgh. Table IIA shows the material cost with $20.00 scrap instead of the current Pittsburgh price. This greatly reduces the material cost in both cases but increases the open hearth excess cost to $8.81 per ton ingots. Pittsburgh and other steel producing centers are scrap deficient areas and under peak operations scrap is at a premium at these points. Large sections of the country have much lower scrap prices, and material costs intermediate between the two extremes of Table II and Table IIA can be obtained in plants located in these scrap surplus areas.

In integrated steel plants the hot metal and cold pig are usually charged to the steel melting furnaces at about $36.00 per ton or $20.00 less than the Pittsburgh price of purchased pig iron. Table IIB shows the material cost under these conditions. The material costs for both types of furnaces are reduced and the excess open hearth cost is reduced to $0.59 per ton.

INSTALLATION COST

The cost of steel plant equipment has gone up tremendously in recent years. The installation costs shown in Table III have been adjusted to 1953 dollars. They are based partly on actual installation costs and partly on estimates and quotations. The data available has been adjusted and modified to put the four plants considered on as nearly the same basis as possible. The cost of land and the cost of bringing tracks, power lines, water, etc., to the plant site are not included. These costs vary so much with local conditions that they are meaningless in a general estimate.

Electric furnaces require much less floor space than open hearth furnaces, so the yard and building costs are much lower. The electric furnace heats are much smaller, so smaller ladles and ladle cranes and fewer charging and ingot buggies are required. Table III shows total installation costs of $7,100,000 for the small electric furnace shop, $10,700,000 for the large electric furnace shop, $12,100,000 for the small open hearth shop, and $17,500,000 for the large open hearth shop. The small electric plant costs 59 per cent of the

TABLE III

Installation Costs and Capital Charges

Annual capacity of plant	250,000 Net tons		500,000 Net tons	
Type of furnace	Open hearth	Electric	Open hearth	Electric
Number, size of furnaces	3-150 Ton	3-60 Ton	4-225 Ton	4-[illegible]0 Ton
General yard work: grading, tracks, pipe lines, sewers, etc.	$ 1,000,000	$ 700,000	$ 1,400,000	$ 1,000,000
Buildings	3,800,000	1,900,000	5,500,000	2,800,000
Cranes	1,600,000	1,200,000	2,000,000	1,500,000
Furnaces and auxiliary equipment	2,600,000	1,400,000	4,200,000	2,400,000
Rolling stock, locomotives, charging buggies, ingot buggies, slag cars, etc	1,000,000	700,000	1,600,000	1,200,000
Material handling, bins, conveyors, fork trucks, scales	800,000	500,000	1,000,000	800,000
Services, water, steam, air, oxygen, power	1,300,000	700,000	1,800,000	1,000,000
Total installation cost	$12,100,000	$ 7,100,000	$17,500,000	$10,700,000
Capital charges per year at 20 per cent	2,420,000	1,420,000	3,500,000	2,140,000
Capital charges per ton ingots	9.68	5.68	6.80	4.28

cost of the small open hearth plant, and the large electric plant costs 61 per cent of the cost of the large open hearth plant. The small electric plant costs 66 per cent of the cost of the large electric plant, and the small open hearth plant costs 69 per cent of the cost of the large open hearth plant.

In usual steel plant accounting practice, capital charges on the installation cost of equipment are not included in the operating cost sheets. Capital expenditures are usually evaluated on the basis of the number of years required for their return. Five years or 20 per cent per year is frequently used and is accepted by the Government for accelerated depreciation on necessary installations. In conventional accounting, fixed charges cover interest, taxes, and normal depreciation and the historical long time figure averaged from 10 to 12 per cent. Under present conditions federal income taxes take about two dollars for each dollar of net income left after taxes in the steel industry. This must be recovered in some way and for the purpose of this paper the use of 20 per cent fixed charges is a simple and realistic way of doing so. The open hearth fixed charges per ton of ingots exceed those for the electric furnace by $4.00 in the small plant and $2.52 in the large plant.

COST OF INGOTS

The overall measure of open hearth vs electric furnaces is determined by the total cost of ingots. This is given in Table IV with scrap and pig iron at current Pittsburgh prices, with cheap scrap, and with cheap pig iron. The cost of ingots with Pittsburgh prices before fixed charges varies from $59.13 to $60.48 per net ton of ingot. There is practically no difference in the cost of ingots from open hearth or electric furnaces with either size plant, but the cost from the small plant is about $1.25 per ton higher than from the large plant by either process. After fixed charges the costs vary from $63.41 a ton in the large electric furnace plant to $70.09 in the small open hearth plant. The electric furnace is $3.93 per ton cheaper in the small plant and $2.59 cheaper in the large plant than the open hearth. The large open hearth plant is $4.09 cheaper than the small plant, and the large electric furnace plant is $2.65 cheaper than the small plant.

TABLE IV

Cost of Ingots Per Net Ton

Annual capacity of plant	250,000 Net tons		500,000 Net tons	
Type of furnace	Open hearth	Electric	Open hearth	Electric
Operating cost Table I	$10.93	$15.05	$ 9.72	$13.70
Material cost Table II	49.48	45.43	49.48	45.43
Total cost before fixed charges	60.41	60.48	59.20	59.13
Fixed charges Table III	9.68	5.68	6.80	4.28
Total cost after fixed charges	$70.09	$66.16	$66.00	$63.41
Cost With Cheap Scrap				
Operating cost Table I	$10.93	$15.05	$ 9.72	$13.70
Material cost Table IIA	33.72	24.91	33.72	24.91
Total cost before fixed charges	44.65	39.96	43.44	38.61
Fixed charges Table III	9.68	5.68	6.80	4.28
Total cost after fixed charges	$54.33	$45.64	$50.24	$42.89
Cost With Cheap Pig Iron				
Operating cost Table I	$10.93	$15.05	$ 9.72	$13.70
Material cost Table IIB	44.47	43.88	44.47	43.88
Total cost before fixed charges	55.40	58.93	54.19	57.58
Fixed charges Table III	9.69	5.68	6.80	4.28
Total cost after fixed charges	$65.08	$64.61	$60.99	$61.86

The *Iron Age* quotes carbon steel ingots at Pittsburgh at $59.00 per ton. This is slightly less than the lowest cost listed before fixed charges and is $4.50 or more below the cost after fixed charges. The necessary conclusion from this is that cold metal shops of the sizes considered are not competitive with the integrated steel plants in the Pittsburgh and other steel producing districts. The only justification for the installation of such plants in these locations would be to assure a dependable supply of ingots for rolling and processing facilities, where the profit is to be obtained from rolling and processing and not from the steel melting shop. For such conditions, electric furnaces are indicated as they give lower cost ingots after fixed charges from either size shop.

With cheap scrap the electric furnace has considerable advantage over the open hearth. Before fixed charges the electric furnace is $4.69 a ton for the small shop and $4.83 for the large shop cheaper than the open hearth. After fixed charges this difference is increased to $8.69 a ton for the small shop and $7.35 for the large shop. The cost of electric furnace ingots, $45.64 a ton for the small shop and $42.89 for the large shop, leaves a margin of $13.36, or $16.11 below the Pittsburgh price of ingots, for administrative and selling expense.

Cheap scrap and high-priced ingots and other steel products usually occur at the same locations away from steel producing districts. The *Iron Age* quoted price of ingots at Fontana in July, 1953 was $82.00 a net ton. This is in the Los Angeles district where scrap was quoted at $20.00 per ton at the same time. This leaves a margin of $36.36, or $39.11 above the cost of electric furnace ingots, for administrative and sales expense and a generous profit. It is admitted that this is an extreme case. However, there are numerous sections of the country with prices intermediate between these and Pittsburgh prices, where electric furnaces can produce steel cheaper than open hearth furnaces and competitively with steel shipped in from major steel producing districts. In New England and much of the West, steel scrap is usually $10.00 or more per ton lower than Pittsburgh prices and steel products are about the same amount higher.

With cheap pig iron, the electric furnace is at a disadvantage. Before fixed charges the cost of electric furnace ingots is $3.53 a ton higher for the small plant and $3.39 higher for the large plant than open hearth ingots. After fixed charges the small plant has a $0.47-higher open hearth than electric furnace cost and the large plant has a $0.87-higher electric than open hearth furnace cost. In general, an integrated steel plant with excess cheap pig iron available for additional steel melting capacity can use this to better advantage in open hearth than in electric furnaces, and it would be preferable to use this as hot metal.

The above figures are general and do not specifically apply to any particular location. Any contemplated installation should be based on a study using local prices and adjusted to local conditions. This discussion indicates that in favorable situations the electric furnace can more than hold its own in competition with the open hearth for relatively small tonnages in nonintegrated steel plants.

SUMMARY

To date, the field for electric furnaces in steel melting is practically limited to cold metal practice. Some hot metal heats have been made experimentally but this practice is not in regular operation.

The higher thermal efficiency of the electric furnace compensates for more than half the higher price of electric energy over heat energy from fuel.

The electric furnace has some advantages over the open hearth in getting materials into and out of the furnace.

Electric furnace steel may be of poorer quality for some purposes than open hearth steel, due to contamination from tramp metals in the higher percentage of scrap in the charge.

Except for alloy contamination, electric furnace steel is as good or better than open hearth steel, and sulphur control is particularly favorable.

The operating cost of electric furnaces is about $4.00 per ton of ingots higher than that of open hearth furnaces, due primarily to more expensive fuel and the high cost of electrodes.

The material cost for electric furnace steel is about $4.00 per ton less than for open hearth steel, based on Pittsburgh prices of pig iron and scrap.

With cheap scrap the material cost for electric furnace steel may be as much as $8.00 or $9.00 per ton less than for open hearth steel.

With cheap pig iron the material costs for the two processes are about equal. The installation cost and capital charges of electric furnace shops are about 60 per cent of those of open hearth shops of similar capacity.

The overall cost of ingots after fixed charges is $2.60 to $4.00 less from electric than from open hearth furnaces with Pittsburgh prices for pig iron and scrap, but the lowest electric furnace cost is still higher than the quoted Pittsburgh price of ingots.

With cheap scrap the cost of ingots may be $7.00 or $8.00 less from electric than from open hearth furnaces. This may be $13.00 to $16.00 less than the Pittsburgh price of ingots and $36.00 to $39.00 less than the price of ingots quoted in some places.

With cheap pig iron the cost of ingots is about the same from electric and open hearth furnaces and higher than the quoted Pittsburgh Price.

The availability of ample quantities of cheap scrap is the most important factor in determining suitable locations for low cost ingots from electric furnaces.

In suitable locations for small tonnages in cold metal shops the electric furnace can beat the open hearth in the production of lower cost ingots with a smaller capital expenditure.

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Developments

IN THE IRON AND STEEL INDUSTRY

During 1953

By I. E. MADSEN

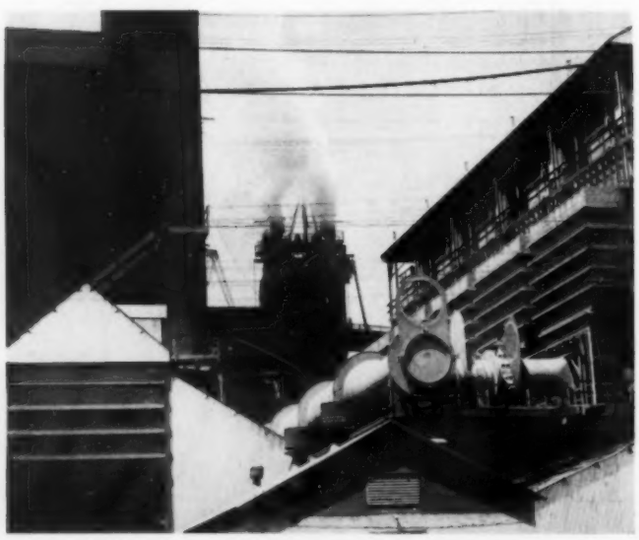
▲ IN 1953 the steel industry found itself able to satisfy industry's voracious appetite for steel for the first time since Pearl Harbor. Even then, this point was not reached until the last quarter. Two factors were of utmost importance in reaching this stage; one was the increased steel capacity which has gone into production, and the other was that 1953, unlike most other years since the war, was a year relatively free from work stoppages. The general public has little realized that production would probably long ago have caught up with demand if it had not been for the numerous work stoppages since the war. Under present conditions, however, even though the industry may not run at full capacity, operations can now drop to 76 per cent capacity and still produce as much steel as 100 per cent operations would produce in 1946.

For the first time since the war, the efficient operator and economical producer will have an advantage in going after orders. For the first time also, the producer can schedule his work to take care of maintenance on a less hectic basis.

Even though the major part of the expansion program is complete, many mill equipment suppliers are almost as busy as at the peak of the expansion program, making plans for further changes and improvements in existing steel plant equipment. Much of this is work long planned, but on which money or authorization has been withheld for a more favorable time. As an example, one steel company was working on 1100 separate plant improvement projects, each costing $25,000 or over. The United States Steel Corp. alone plans to spend about $300,000,000 in new equipment or replacements during 1954.

It has been estimated that steel plant modernization

Although the steel industry went at full blast throughout the year, every effort possible was being made to reduce the smoke and dirt which accompanies all-out production. Views are before and after scenes which show the effect of the air cleaning equipment installed on the ferro-manganese furnace at the Duquesne works of United States Steel Corp.



and expansion since 1946 has averaged $180 per net ton of additional capacity, including modernization of finishing facilities. Ingot capacity alone has been developed for as little as $16 a ton, although a new completely integrated mill may run as high as $300 per ton of net capacity.

The year 1954 should be the good year for industry, and present estimates indicate that it will be the second best year as far as capital spending is concerned. Plans indicate that $11,683,000,000 will be spent for manufacturing industries compared with an estimated $12,690,000,000 in 1953. Of this, about $1,108,000,000 will be spent in the steel industry in 1954, down 24 per cent from the $1,460,000,000 (estimated) spent in 1953. Total expenditures for all new projects for industry, transportation, utilities, and commerce in 1954 are estimated at almost $27,000,000,000 compared with about $28,000,000,000 in 1953.

It was estimated that, in spite of the decline in steel production late in 1953, total steel production set a new record high in 1953 with about 111,600,445 net tons, the highest ever, or 95.0 per cent of capacity, compared with 93,168,039 net tons or 85.8 per cent of capacity for the year 1952. Of this, estimated figures give 100,473,930 tons for open hearth production or 98 per cent of capacity, 3,855,892 tons of bessemer production or 83.3 per cent capacity, and 7,270,623 tons of electric steel production or 71.2 per cent capacity. Finished steel output totaled about 80,000,000 tons. Total pig iron production for the year 1953 is estimated at 76,000,000 tons or 95.8 per cent of capacity compared with 62,150,926 tons in 1952. Estimated iron production for 1953 includes about 860,000 tons of ferromanganese and spiegel.

The previous record year for steel production was 1951 with 105,200,000 net tons. During 1953, the first month in which more than 10,000,000 tons of steel were produced occurred in March.

Steel production slowed down in the fourth quarter of 1953, dropping to 95 per cent of capacity during October. The rate kept going down with an average of about 90 per cent capacity for the last quarter, and a low of around 76 per cent at Christmas.

Optimism, however, was expressed for 1954 prospects, and Benjamin F. Fairless of United States Steel predicts steel operations the first quarter will average about 95 per cent. Eugene G. Grace, chairman of Bethlehem Steel and George Fink, president of Great Lakes Steel also expressed views that they will have good years in 1954. Looking forward toward 1954 business, Mr. Fink stated that their order books are full for the first half. This company expects that 5,000,000 automobiles will be made in 1954 compared with about 6,000,000 in 1953.

In general, the steel industry believes that production in 1954 will run between 95,000,000 and 100,000,000 tons.

The reduction in steel business was reflected by some companies who absorbed some freight, and in other cases price adjustments in certain products were reported. However, even though the market found itself in balance with demand, and even though the ingot rate dropped slightly, readjustments were orderly. A great deal of the reduction in demand was apparently due to correction of inventories on the part of the buyers when they estimated that steel products would become plentiful and available. Among the products which felt the reduction in business worst were large carbon steel bars, and wire and wire mill products.

The American Iron and Steel Institute announced at the close of the year that it is planning to use a new statistical index to measure the steel industry's ingot production. This new index will be based on the average annual production of three years (1947, 1948, and 1949) as 100 per cent. Production will be figured percentagewise on this base total. This is the same base period as the government has been using in several recent revised indices. The average annual production in this period was 83,837,572 net tons, which is an output greater than any prior year except 1942, 1943 and 1944.

The reason for doing this is the large increase in production capacity by the steel industry over the past several years. A new index will thus give a better comparison of volume of steel production with previous years regardless of changes in capacity. As an illustration of the effect on the figures, for the week beginning December 14, production on the old base was scheduled at 84.3 of 1953's capacity of 117,547,470 tons. On the new index, the production for this week would be listed as 118.2 per cent of the base.

As of January 1, 1953, steel capacity was 117,547,470 net tons. An additional 6,782,940 tons were added in 1953, raising official capacity to 124,330,410 net tons as of January 1, 1954. Some additional will come into production in 1954 and 1955, and some marginal capacity will be retired. As of January 1, 1953, blast furnace capacity was 79,380,240 tons. Some 2,621,150 tons of blast furnace capacity were added in 1953, making an-

Newly completed facilities of Armco Steel Corp. at Ashland, Ky. are shown in this aerial view. The building housing the new hot strip mill is almost one-half mile long. New office buildings and a gate house have also been completed.

nual capacity 82,001,390 net tons as of January 1, 1954. About 900,000 tons will be added in 1954. On January 1, 1953, coke capacity *of plants associated with iron and steel industry* totaled 71,181,190 tons. About 2,058,350 tons of coke oven capacity were added in 1953, raising capacity to 73,239,540 tons as of January 1, 1954. Some 900,000 tons of additional coke oven capacity are scheduled for 1954, and some 200,000 tons after 1954 for the basic iron and steel producing industry. Total annual coke capacity in the United States on January 1, 1953 totaled 88,432,800 tons of which 76,428,000 tons were by-product capacity and 12,004,800 tons were beehive capacity. A total in the United States of about 7,000,000 tons of by-product capacity was built in 1953, and about 2,000,000 tons were abandoned leaving a net gain of 5,000,000 tons. Since about one-third of all by-product ovens are over 25 years old, about 5,000,000 tons of by-product capacity must be added each year to maintain present capacity.

One outstanding factor in analyzing expansion is that the ability to finish steel has grown at a greater rate that that to produce ingots. In the last thirty years, finishing capacity has grown about 200 per cent and ingot capacity 78 per cent.

The expansion of the steel industry in the last three years has been planned primarily with an eye to better integration of steelmaking facilities and obtaining better balance between various segments of the plant. In general, excess of finishing capacity is essential in meeting fluctuations in the demand for various types of product. On the items of equipment on which certificates of necessity were granted, approximately $1,600,000,000 were spent on basic steel plant expansion compared with $1,300,000,000 for finishing facilities. In this breakdown $577,000,000 was spent for blast furnaces, $579,000,000 for steelmaking, $362,000,000 for semi-finished productive capacity, and $91,000,000 for utility and general plant. A survey made by the DPA-NPA shows that steel industry was spending more money on sheet, strip and black plate finishing facilities than on equipment for other products. On these products it was spending $714,000,000; $268,000,000 was being spent on plate and tubing; $103,000,000 on bar products; $69,000,000 on coated tin mill products; $41,000,000 on rods, wire and wire products; $35,000,000 on shapes and piling; $23,000,000 on plates; $7,000,000 on forgings; $3,000,000,000 on rails and accessories, and $2,000,000,000 on castings.

Employment costs in the iron and steel industry were estimated to have gone up about $150,000,000 annually as a result of the wage settlement reached in June by steel companies and the steelworker's union. Production and maintenance employees received 8.5 cents an hours, salaries were increased, and pension and social security costs also went up. As a result of the raise, the lowest starting rate is now $1.52 and the highest $3.22½ per hour. Southern rate differential is cut from 5 to 2½ cents effective January 1, 1954, and this will be eliminated completely on July 1, 1954.

As a result of the wage boost given the workers by the steel industry, prices of many products went up shortly thereafter. These price changes averaged about $4.00 a ton.

Rumblings of future labor trouble were evident at the conference of the United Steelworkers in the fall. The main issue up for discussion was that of the guaranteed annual wage. Emphasis in the discussions was also placed on pensions and insurance.

The FTC stated during the year that it believed that a business firm can legally give one customer a lower price than it gives other customers provided the price reduction is made in good faith to prevent the customer from buying from a competitor. This was a reversal of long standing policy. In this statement, the commission mentioned that they believe that such price cut can specifically include lawful competitive absorption of freight charges where necessary. The new policy does not legalize the basing point or other rigid price systems.

As a result a number of the steel companies announced during the year revised sales policies under which the companies will quote prices fob its mills or if the customer desires, delivered prices which reflect full transportation charges from shipping point to destination. This system also contemplates revising or meeting lower delivery prices of competition when necessary and desirable in order to obtain the business.

A new development in pricing was announced by the Republic Steel Corp. on December 15. Under this new pricing system, prices for hot rolled carbon steel bars will be based on a delivered base price to any common carrier destination in each of the 1481 counties to which Republic normally ships this product. The delivered base price consists of the mill price per 100 lb plus all transportation charges. This system will simplify paper work for both the buyer and the sales department.

An interesting development in marketing steel is that steel warehouses and independent distributors have gone into processing on a fairly large scale in an attempt to serve their customers. Equipment is available in many such warehouses which will slit or cut steel to intricate shapes, and equipment is available in

some warehouses to roll material to different thicknesses, finish or temper. The purchaser can even specify such refinements as square, smooth round, beveled or other special shaped edges on the strip which he purchases. In order to take care of these requirements, bigger and more complicated steel processing equipment is being installed in warehouses.

Profits of the steel industry in 1953 formed a very bright side of the industry's operations. As an example, profits in the third quarter of 1953 were double the third quarter of 1952. For the first nine months, profits in 1953 were 86 per cent higher than those in 1952. Profits in 1952 were, of course, adversely affected by the 54-day industry-wide strike, about half of which took place in or affected third quarter operations.

A reduction on railroad freight rates in the South of about 20 per cent and the elimination of a 15 per cent surcharge giving an overall reduction of 30 per cent on iron and steel products in the south have put the eastern and southern sections of the United States in approximate balance for the first time in the history of the railroads. The new southern rates also narrow the gap between rail and truck rates.

A trend on the part of some steel companies is that of diversification. Republic Steel, for example, in the past few years has gone into the fields of titanium, plastic pipe, steel kitchens and iron powder, making it much more than a producer of steel products. One other company operates on the basis that new products are the key to its growth, and tries to add at least one item a year.

The development of a code for the identification of steels progressed during the year with the issuance of such a code by the Canadian Government Specifications Board. This covers both hot and cold rolled finished shapes. It is not intended to be applied to steels to be used immediately after delivery. In this code, cold finished shapes are identified by ink stampings, and hot rolled shapes by indentation stampings. Both of these are supplemented by a standard color code which covers 24 sub-groups.

The Defense Department in this country has been pushing a plan which will require all suppliers of steel and nonferrous shapes to identify their products with a uniform marking system starting sometime this coming year. The Defense Department feels that this marking system should include all rolled metal shapes —ferrous and nonferrous, alloy and non-alloy. This system will probably be a printing instead of a color system.

A number of blast furnace units are still to be completed. Furnace shown is American Steel and Wire Division's "A" furnace which is located in Cleveland, Ohio.

DETAILED EXPANSION

Although the tempo of expansion slowed down appreciably in 1953 as far as new projects are concerned, there was practically no plant in the country that was not improving or adding to its facilities. On the other hand, completion of facilities under construction took place at a very fast rate.

The huge new Fairless works had all its principal facilities in operation when the 10-in. bar mill started on November 4. Official opening of this plant is expected to take place during the coming spring.

In the Far West, Columbia-Geneva Steel Division of U. S. Steel started a $30,000,000 sheet and tin plate addition at Pittsburg, Calif. Principal facilities consist of a new 4-stand cold reduction mill, a second high speed (1250 fpm) electrolytic tin plate line. Combined tin plate capacity, including hot dipped is estimated at 350,000 tons annually.

The Clairton plant of United States Steel pushed coke on three new 61-oven coke batteries in 1953. The No. 14 battery started on January 28, No. 13 on March 16, and No. 15 on May 12. Each of these three batteries can produce 966 tons of coke per day. Three batteries of ovens were taken off during the year, No. 7, No. 8 and No. 9 on April 17, April 24 and May 8, respectively.

Clifford F. Hood, president of the United States Steel Corp., stated last year that they had increased their steelmaking capacity in the Chicago district by 1,382,000 tons since 1946.

United States Steel Corp. broke ground during the year for the construction of a modern research center at Monroeville which is near Pittsburgh, Pa. Completion is scheduled in early 1955.

United States Steel Corp. also closed the historic 83-year-old career of their Isabella furnaces at Etna, Pa. This pioneer plant has been a producer of ferromanganese for the last 51 years. Contracts for wrecking the plant have already been let.

United States Steel Corp. announced an extensive program to augment its finishing facilities at its Vandergrift plant to produce grain oriented silicon sheets. Equipment to be installed includes continuous annealing lines, a new high temperature box-type electric annealing furnace, and a new box type gas-fired annealing furnace. The entire program should be completed in 1955.

A. V. Weibel, president of the Tennessee Coal & Iron Division, reported that engineering and operating progress during the year had increased the division's annual steelmaking capacity to 3,831,000 tons on January 1, 1954, up from 3,455,000 tons on January 1, 1953.

The American Steel Wire Division of U. S. Steel announced that it will construct a new rod mill at its Cuyahoga works in Cleveland. The mill will be a combination rod and billet mill rated at 450,000 tons annually. It will handle billets 3¼ in. square and 30 ft long, weighing 1050 lb. Finishing speed is expected to be over 60 mphr, almost twice that of the existing equipment. Rolling range of the mill will be from No. 5 rod to 1¼ in. Estimated cost is $10-20,000,000.

American Steel & Wire Division of U. S. Steel Corp. broke ground for a new blast furnace at their Cleveland plant on May 12. This has a 26-ft hearth diam, and is 228-ft 6 in. from the yard level to the top of the furnace. It is rated at 1350 tons of iron per day. Air is driven by a steam-driven turbo-blower having a capacity of 110,000 cfm at 30 psi. Three single compartment electrostatic precipitator units, each 21 ft 6 in. in diam, are used to clean 135,000 cfm of gas down to a cleanliness of 0.01 grains per cubic foot. Three, two-pass stoves 25 ft 0 in. in diam x 114 ft 0 in. high, having 211,000 sq ft of heating surface each, are used on this furnace. Estimated cost is $11,000,000 and unit will be used for merchant iron. Completion is scheduled for late in 1954.

American Steel & Wire Division's Cleveland works also put into operation a rebuilt battery of 45 coke ovens during the year. This is the third of their four batteries to be completely rebuilt in the last four years. This battery D will produce 625 tons of coke per day.

In the latter part of the year, Republic Steel Corp. announced they will increase rolling capacity of stainless steel at its Massillon plant by about 20 per cent. Expansion plans include a wide cold reducing mill, and a 26-in. two-high, skin pass mill. The cold rolling mill will handle 48-in. wide strip. Plans include auxiliary annealing and pickling lines, shearing lines, grinders and materials handling equipment. Rolling capacity for stainless will be increased by 1800 tons a month.

Expenditures for additions, and improvements by the Jones & Laughlin Steel Corp. totaled about $50 million in 1953 compared with $84 million in 1952. This work included the new 10-in. bar mill at the Pittsburgh works which began operation on January 27. Another project was the electrification of the blooming mill at Aliquippa. Other work by the corporation under way involves improvements and expansion on underground iron ore mines in Michigan and on mining and concentrating facilities at their Benson Mines. Jones and Laughlin Steel Corp. installed a battery of 79 coke ovens with a monthly capacity of 39,500 tons which started production on December 1 at their Pittsburgh works at an estimated cost of $11,600,000.

Youngstown Sheet & Tube Co. put into production a third blast furnace at its Indiana Harbor works, East Chicago, on February 24. It is 105 ft high, has a 28-ft. hearth diameter, and has a rated capacity of 1500 tons a day. A blooming mill and cold rolling unit were also under construction at this plant.

The Bethlehem Steel Co. put into operation several new blast furnace units in 1953. One of these was the "D" furnace which started operation at the Bethlehem plant in March. This unit is rated at 1500 tons and is 28 ft 9 in. in diameter. Another furnace at this plant, the "B" furnace, which will be a duplicate of this unit, is scheduled to go into operation in March or April of 1954. Both of these furnaces at Bethlehem replace older 700-ton units, and have been placed on the site of the old furnaces.

Bethlehem Steel also put into operation a new furnace, the "J" furnace, at its Sparrows Point plant on July 24. This unit has a 28-ft hearth diameter.

Bethlehem Steel has also been increasing coke oven capacity at its four manufacturing plants as well as adding miscellaneous equipment to finishing facilities. A new battery of by-product ovens at Bethlehem Steel Co.'s Bethlehem plant went into operation in 1953. This is the first new battery built since 1916 and will add 1,300 tons to the daily production of the four existing batteries at this plant, giving it an annual coke production of 2,300,000 tons. A 65-oven No. 10 battery was completed at the Sparrows Point plant in 1953 and a similar unit, the No. 11 battery should be completed in 1954.

E. T. Weir, chairman of National Steel, announced during the year that an $85,000,000 expansion program would be authorized at Weirton, W. Va., provided the excess profits tax is eliminated. The program would increase capacity of tin plate annually from 22,000,000 to 29,500,000 boxes of tin plate. Enlargement of finishing facilities for galvanized sheet and specialty products would be included. The present 54-in. continuous hot strip mill would be converted to a 66-in. mill, and a new electrolytic tin plating line would be installed.

Great Lakes Steel Corp. received a certificate of necessity for a $10,800,000 expansion of steel sheet, plate and strip facilities. The company reached an ingot capacity of 4,000,000 tons on December 1, hitting that point a full month ahead of the original schedule. The company completed a 45 x 90-in. slab mill on October 23, two months ahead of schedule. This mill is of the latest design, driven by 16,000 hp, and can handle ingots weighing up to 20 tons. It can turn out slabs weighing up to 8 tons. Estimated cost of the new slabbing mill is about $35,000,000.

Great Lakes now has 17 open hearths, four bessemers of which two are new, one 40-in. and one 46-in. blooming mill, a 45 x 90-in. slabbing mill, a 21-in. bar mill, a 34-in. and a 96-in. strip mill, a 10-in. and 14-in. merchant mill, and one 54 and two 96-in. cold mills. Four blast furnaces are in operation at Zug Island. In operation are 146 coke ovens and 70 are under construction.

As of January 1, 1954, Inland Steel Co. had a rated annual production capacity of 4,700,000 ingot tons of steel, an increase of 200,000 tons. The increase was gained by enlargement of four open hearth furnaces from 170 to 200 tons at the company's Indiana Harbor, Ind., works during the last year, the incorporation of improved design in their rebuilding, and the adoption of improved operating practices. This expansion followed the 750,000-ton increase in annual capacity in 1952 attained by construction of four new furnaces at Inland's No. 3 open hearth shop.

One of the large expansion programs practically com-

pleted during the year was that undertaken by the Pittsburgh Steel Co. in the Pittsburgh district. With this program, Pittsburgh Steel has entered the flat products field and jumped in standing from 14th place to 11th among the steel producers in the country. At this plant, each of the 12 open hearth furnaces was enlarged from 150 to 250 tons capacity, increasing steelmaking capacity from 1,072,000 to 1,560,000 tons per year. This increase was accomplished at a cost of $16.31 per ton for increased capacity at the open hearth. Three new 300-ton ladle cranes were installed. The program also includes an increase in blast furnace capacity by about 12 per cent, and installation of a 66-in., high-lift blooming-slabbing mill, a hot rolled sheet-strip mill, and a 66-in. cold rolled sheet strip mill.

The New England steel mill showed signs of life again during the year. The Office of Defense Mobilization authorized rapid amortization on 65 per cent of the estimated cost ($26,400,000) of erecting a 300,000-ton steel plant in New England. The certificate was issued to the New England Steel Development Corp. Plans include two electric furnaces, both of which will use all-scrap charges and a rolling mill. The site of the plant has not been selected. Backers of the mill have as yet not been announced. As now proposed, the plant is a far cry from the completely integrated mill which was first under consideration and pushed by the New England council.

Colorado Fuel and Iron increased its steel capacity to 2,425,000 tons annually. A big factor in this increase was the purchase of the John A. Roebling's Sons Co. at Trenton, N. J. As a result, almost half of Colorado's operations are now being carried out east of the Mississippi. This is the third company purchased by them in the last three years. Outstanding in the program of Colorado Fuel and Iron is a $27,000,000 seamless tube mill which was completed at Pueblo, Colo. This mill has an annual capacity estimated at 175,000 tons and is the first seamless mill west of the Mississippi River.

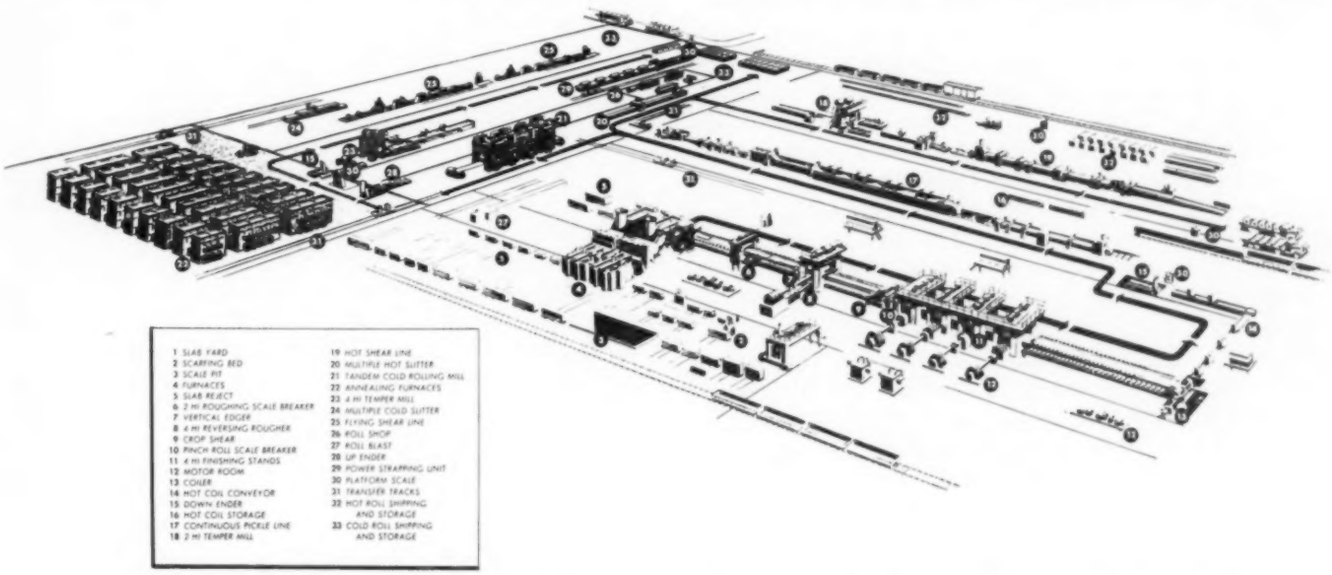
Much of Allegheny Ludlum Steel Corp.'s expansion has taken advantage of new advances in steelmaking. This company has completed an $80,000,000 expansion program since 1946. Of unusual interest in their program are the operations at Watervliet, where a hot extrusion process is being used for the production of stainless steel seamless and other high alloy tubes and shapes. Extrusion is done with a press having a capacity of 1778 tons. At this plant there is also a pilot continuous casting plant in operation. One of its advantages is the elimination of a reheating operation as well as the blooming mill operation.

Allegheny Ludlum also completed a new 56-in. semi-continuous hot sheet-strip mill at its Brackenridge plant. This mill will be used primarily for the production of stainless and silicon steel sheet and strip. It includes a universal reversing roughing mill, and a six-stand finishing train. Construction has been started at Brackenridge on a 56-in. 4-high, four-stand tandem cold mill which is scheduled for completion late in 1954.

A new 80-in. continuous hot strip mill went into operation at Armco's Ashland, Ky. plant. The mill is rated at 150,000 tons per month. When this mill went into operation on May 20, Armco Steel was operating side by side, the oldest and the newest hot strip mill in the country. Armco Steel also started a new $40,000,000 blast furnace coke oven plant at Middletown, Ohio, April 14. It is rated at 1300 tons of pig iron per day.

Detroit Steel blew in a new blast furnace at its Portsmouth, Ohio plant on August 27. This unit has a hearth diameter of 28 ft 6 in. and is rated at 1400 tons per day. Four new 250-ton open hearths are scheduled for completion sometime in the early part of 1954. Other improvements in their $60,000,000 program which will be completed next year are new soaking pits and a 48-in. high lift blooming-slabbing mill. Completed in 1952 are the 56-in. hot and 56-in. cold strip mills and a number of other facilities.

Steelmaking capacity will expand in the Detroit area with the expansion program announced by McLouth Steel Corp. This company plans a $105,000,000 expansion which will make it an integrated producer. Steelmaking capacity will go up 100 per cent from present



New hot and cold rolling facilities mark the entrance of Pittsburgh Steel Co. into the sheet steel market.

579,000 tons to 1,200,000 tons by end of 1955. Program includes new ore dock, a blast furnace, two new 200-ton electric furnaces, two converters, new soaking pits, a continuous hot strip mill, and additional finishing mills which will double company's capacity for hot and cold rolled carbon strip and sheet to about 935,000 tons a year. Part of the financing will come from General Motors Corp. who are advancing a $25,000,000 loan. American Metal Products are also in on financing. Some of this will be repaid in finished steel. This is the fourth entrance by General Motors into the steel industry. General Motors has previously advanced money to Jones & Laughlin, Republic Steel and Algoma Steel Corp.

Alan Wood Steel Co. announced that they will start construction of a $6,000,000, 4-stand tandem cold strip mill at their plant at Ivy Rock, Pa. Completion of this mill is scheduled for the first quarter of 1955. It will have an initial estimated capacity of 120,000 tons and will be adjacent to the hot strip mill which went into operation in 1950.

Green River Steel Corp. of Owensboro, Ky., went into production on July 8. This is the only completely new steel company which has gone into production since the war. The plant uses electric furnaces and has an ingot capacity of about 200,000 tons per year. Product mix will include blooms from 6 x 6 to 12 x 12-in., slabs, billets up to 8 x 8 in., bars from 2 to 8⅝ in. and tube rounds up to 8⅝ in.

One of the unusual features is the use of the Dornin process which, it is claimed, will give a minimum of 90 per cent sound steel from ingots, compared with the 78 per cent average from ordinary hot tops. In this process the ingot is teemed into a big-end-up mold with a heavy taper (two to three times the usual). The segregate zone is punched on a heavy press and isolated by upsetting. The ingot then is forged to the rolling shape on another forging press. They are then returned to the soaking pit for flash heating for about 20 minutes, when they are ready for rolling.

The facilities in this plant include two 70-ton electric furnaces, eight soaking pits, each capable of handling a 60-ton electric furnace heat, a 2500-ton upsetting press and a 1500-ton forging press, a 25-in., two-high, reversing blooming mill, and a two-stand 24-in. bar mill. This steelmaking practice requires more than the normal soaking pit capacity.

More steel capacity came into being in the Mississippi River Valley. At Granite City Steel, a 46-in. blooming mill went into operation on April 2. This mill was originally built for Czechoslovakia. A new four-high reversing roughing mill went into operation in the summer, where slabs are broken down before going into the five-stand, four-high, continuous hot strip mill. Granite City also added six, three-hole soaking pits and three slab heating furnaces. Three new 300-ton open hearth furnaces went into production during the year and supplement the previous four 250-ton open hearths. The nine 60-ton open hearths may become stand-by capacity. Also 27 new coke ovens have been added to supplement the present 49 coke ovens. Annual ingot capacity added will raise total capacity to 1,200,000 tons, or double that of 1953. With the completion of this expansion, Granite City Steel facilities are in balance. Cost of expansion was about $68,000,000.

Laclede Steel is increasing its ingot producing facilities by 60,000 tons a year by enlargement of the two smallest of four open hearths. At Alton, Ill. Laclede replaced the steam drive of its blooming mill with a 5000-hp electric reversing motor. This went into operation during the summer and raised blooming mill capacity from 40,000 to 65,000 tons per month. Electric manipulators also replaced hydraulic manipulators.

Continental Steel Corp. started its new 1000-ton per day rod mill at Kokomo, Ind. The mill has facilities for producing wire and rod from No. 5 to 1 in.

Early in the year West Virginia Steel and Manufacturing Co. went into the field of basic steel production. This company has been operating a rerolling mill for a number of years, and now completed an electric furnace which will enable it to produce basic steel. The company also installed four soaking pits and a reconditioned bloomer.

For the seven western states only, of Washington, Oregon, California, Idaho, Utah, Nevada and Arizona, steel ingot production in 1953 was estimated at 5,200,000 tons for an average operating rate of 93 per cent of the area's 5,800,000 ton capacity. Of this, 84 per cent is concentrated among three producers, U. S. Steel with 2,200,000 tons; Kaiser with 1,500,000 tons and Bethlehem Pacific with 900,000 tons. The largest single tonnage item here was plates with almost 1,000,000 tons. Leading products, in order of tonnage, were hot-rolled bars and bar size shapes, plates, sheets and strip, tin mill products, other products, pipe and structural shapes. California used 80 per cent of all the steel consumed in the seven states of California, Oregon, Washington, Arizona, Nevada, Utah and Idaho.

Kaiser Steel Corp. announced an $8,000,000 program at the end of the year for expansion of its Fontana, Calif., rolling mills that will increase production of steel plate, sheet and tinplate by 120,000 tons per year. New facilities to be built include an expansion of the continuous electrolytic tinning line to increase capacity from 130,000 to 200,000 tons per year, a new handling and conditioning yard for slabs is to be installed, as well as a third slab heating furnace for the plate mill. The blooming mill will be modified to produce steel slabs 48-in. in width, or one-third wider than the present 36-in. wide slabs.

Kaiser Steel put its third blast furnace into operation during the year. This unit has a rated capacity of 438,000 tons of pig iron per year, raising total capacity of the plant to 1,314,000 tons of pig iron annually. Included in their program was a ninth 200-ton open hearth furnace which started operations in January which increased the annual capacity of the plant to 1,536,000 ingot tons. An additional 90 new coke ovens with a capacity of 410,000 tons of coke per year supplies additional fuel for the blast furnaces and in addition eliminates the need for outside purchases of coke. Kaiser now has 225 ovens.

Another item of expansion in Kaiser's program this year was a fifth and sixth stand which were added to the four-stand, 86-in. mill in the tin plate plant. These stands enable Kaiser to roll thinner gauges. Supplementing this is a new shear line for hot rolled sheets.

Lone Star Steel Co. became a fully integrated plant this year with the completion of four open hearth furnaces, rated at 188 tons, and actually producing about 250 ton heats for an annual capacity of 550,000 tons per year. Two pipe mills are operating which can turn out products at a 400,000-ton annual rate.

Yolo Steel & Metal Co. of Sacramento, Calif., which has been granted a number of certificates of necessity, received one of $11,000,000 for electrolytic tin plate mill during the summer. This makes it a $137,000,000 enterprise, but no reports have been issued indicating that any actual work has been done so far.

FOREIGN PLANTS

Worldwide steel production in 1953 was about 11 per cent greater than in 1952, with a figure of 254,600,000 net tons compared with 229,400,000 net tons in 1952. Of this total, the free world nations produced over 200,000,000 tons. About half of the steel producing countries established new all time production records in 1953. Total production was, however, appreciably less than the 266,000,000 tons predicted one year ago.

It was estimated that steel production in the United States totaled about 111,600,000 tons, second was Russia with about 42,000,000 tons, up from 36,000,000 tons in 1952. The United Kingdom was third with 19,700,000 tons, up about 1,000,000 tons from 1952. Production in West Germany was fourth with about 17,000,000 tons. France produced 11,000,000 tons; next was Japan with 8,000,000 tons.

Steel output in Belgium in 1953 was estimated at 5,000,000 tons compared with 5,607,800 tons in 1952, or a drop of just over 10 per cent. Part of this drop is due to the fact that steel exports fell off because of their decline in foreign trade.

A plant in Belgium ordered an electric arc furnace which will be among the largest in the world. This unit will have a diameter of 24 ft and a capacity of about 140 tons. Electrical equipment includes a 30,000-kva transformer.

Output of steel for ingots and castings in Sweden increased about 3 per cent to 1,900,000 tons in 1953. Sweden is engaged in a steel expansion program which will raise capacity to almost 2,500,000 tons by 1955.

Great Britain's production was a new all-time production record. Thus, Britain alone, among major western powers increased its output of steel in 1953 over 1952. The total of the major Western European steel producing countries under the Schumann Plan, France, Belgium, Luxembourg, the Saar, West Germany, Italy, and the Netherlands was nearly 2,500,000 tons of steel less in 1953 than in 1952, with 43,500,000 tons in 1953 compared with 46,000,000 tons in 1952. The Schumann Plan countries opened up their common market for steel on May 1. The program was started on February 10 with coal, iron ore and scrap. One of the first moves of the European Coal and Steel Community group was the imposition of the first super-national European tax. This tax varies from 0.3 per cent of the net value coal or steel produced up to 0.9 per cent. The money will be used for guaranteeing investment loans needed for expansion among the members and for some other purposes. The ECSC group plans to push an expansion program which will increase steel capacity about 8,000,000 tons to 54,000,000 tons by 1956, and coal production from present 240,000,000 tons to 280,000,000 by 1957-1958.

Contrary to popular expectations, the initial denationalization of the British steel industry has been quite a success. For one company, the United Steel Companies, Ltd., the Churchill Government received requests for three times the amount of stock which was offered. It had been mistakenly feared that private investors would be afraid to put their money into these steel stocks because of labor's threat to nationalize again should they come into power.

Another plant, Templeborough Rolling Mills, went to the original owners, British Ropes, Ltd., and William Cooke & Co. The British Iron and Steel Holding & Realization Agency (the Government group selling the stock) received the equivalent of $20.30 per share of stock. Each company took 72,000 shares each.

Britain is still planning for increased production. The second stage of its program is now being started and is based on estimates of steel demand of 1957 when it is felt that 22,000,000 net tons of steel will be required. Major portion of this expansion will be done by the big producers. Steel Co. of Wales at Margam are planning to spend $127,400,000 for blast and open hearth furnaces to keep up with their new hot mill. Dorman, Long & Co. are planning to spend more than $100,000,000 on two large blast furnaces at Cleveland, and an open hearth furnace at Lackenby.

The open hearth shop of John Summers & Sons, Ltd., near Chester, containing eight 150-ton furnaces, is in full operation. These facilities were formally opened on April 29. Output of the plant was increased by about 50 per cent.

Italy is dependent to a large degree on foreign raw materials. A United Nations study showed that Italy must import 25 per cent of its iron ore, 25 per cent of its scrap, 90 per cent of the coal and 100 per cent of the coke used in steelmaking production. Output of pig iron in Italy in 1953 was 3½ per cent higher than in 1952. Output of steel for ingots and castings, however, dropped by about 2 per cent to 3,800,000 tons.

One of the handicaps to the growth of the steel industry in Italy may be overcome. Studies are under way on the problem of reduction of ore by methane instead of coke. The solution to this, however, has a long way to go. One compensating factor in Italy is their rich ore deposits which reduce coke consumption to about 1600 lb per ton.

The program in Italy is about as follows: At Bagnoli, which is near Naples, plant capacity will be 440,000 short tons of pig iron and 400,000 tons of steel billets, bars, and small rolled products. This plant has four 60-ton open hearths, and four 30-ton basic bessemers.

At Piombino, a new steel plant halfway between Rome and Genoa, production will be 275,000 tons of pig iron and 300,000 tons of steel, which will consist primarily of rail and railroad track. Piombino has three 150-ton open hearth furnaces and a 45-in. bloomer. Open hearths operate on methane and also on 80 per cent gas and 20 per cent oil. The use of 20 per cent oil increases the hourly production rate about 10 per cent.

At a new integrated steel plant at Cornigliano, which is near Genoa, the program contemplates 475,000 tons of pig iron and 650,000 tons of steel plate, strip and sheet. Ultimate program is 1,100,000 tons of steel. Production started in 1953, and one blast furnace, one open hearth, and a reversible hot rolling mill are operating. Other facilities will be in operation in 1954.

Several British companies have obtained contracts in Spain for the construction of a new iron and steel plant to be built at Aviles on the north coast. This plant is scheduled to produce 350,000 tons of steel a year by the end of 1956 or early in 1957. Plant and equipment include a 42-in. blooming mill, and a 32-in. structural mill. A new direct reduction plant is also now being built in Spain.

During the year Albania started construction of a small electric furnace steel plant with an annual capacity of 20,000 tons of stainless and special steels.

Expansion of Brazil's steel industry is being promoted by the German Mannesmann and Kloeckner steel groups. The Mannesmann plans are being handled by Commercial e Industria Mannex do Brasil, S.A., its sales organization. They have approved plans for the construction of a modern seamless tube plant in Belo Horizonte, the capital of Minas Gerais. The operator of this new plant will be listed as Companhia Siderugica Mannesmann. The mill is designed for annual capacity of 80,000 tons of tubes. Production is scheduled to start early in 1954. Eventually the company plans to build its own steel mill with a capacity of about 100,000 tons of steel. Steel plant will probably use the Minas Gerais iron ores which have an iron content of about 66 per cent. Due to lack of coke, it is expected that the Niederschacht process will be used, whereby coke requirements are cut down to about 25 per cent of normal. A great deal of electric power will be required, however.

The Kloeckner Works project is for a small 60,000-ton steel plant at Victoria, capital of Espirito Santo. Local company involved is Companhia Ferro e Aco de Victoria. There is also a seamless tube mill with an annual capacity of about 40,000 tons being built by a group of Brazilians near Sao Paulo. Equipment for this plant has been purchased in England.

Steel capacity at Volta Redonda has reached 700,000 tons annually. A new blast furnace went into operation in the fall. Plans are also under way for further expansion of these facilities to reach a production of more than 1,000,000 tons of steel ingots per year. At present, the plant has five open hearths and two blast furnaces. A structural mill was recently completed.

Other recent developments in Brazil show the growing strength of the steel industry in Brazil. Cia Mineracao do Brazil plans to build a $10,000,000 steel mill in Lafayette, Minas Gerais. The new seamless tube mill of this company at Mogi das Cruzes went into production in November.

Another plant for Brazil is being planned by Siderurgica Paulista Cia. located at Piassaguera, Brazil. Completion is planned for 1956. Ultimate capacity of this mill is set at 1,000,000 tons per year and estimated cost is $110,000,000.

In Peru, an up-to-date steel plant is being built at Chimbote by the Corporation Peruana del Santa, a government organization with an authorized capital of 600,000,000 soles. The plant, with an annual capacity of 60,000 tons, consists of two electric furnaces and one rolling mill. Construction was started in 1951 and completion is scheduled for April, 1954. The rolling mill is being furnished by French plants, and the electric furnace is being furnished from Norway.

The steel plant proposed for Colombia at Belencito is being financed by a special tax of about 2½ per cent on everyone earning over $4000 a year. This tax will give them an interest in the mill as stockholders. High iron ore deposits estimated at 100,000,000 tons are located near the location. Initial installation will have a pig iron capacity up to 180,000 tons per year, from one blast furnace having a nominal capacity of 500 tons per day. The coke plant will consist of a battery of 43 ovens with a daily production of 1140 tons. Three basic lined converters of 22 tons capacity will make the steel. A 50-ton electric furnace is also included. Rolling mills are being installed for semi-finished and finished products including plate, structural sections, etc. A merchant mill has an annual capacity of 100,000 tons. Completion of the plant was set for the beginning of 1954.

Two German companies, Freidrich Krupp & Co. and Demag (Deutsche Eisen Metall, A.G.) made an agreement with an Indian group to build a $150,000,000 steel plant in India. This plant will produce 500,000 tons annually at the beginning, and if all goes well, will eventually be expanded to 1,000,000 tons. The steel plant will be owned by the Indian Government and private interests, with the Government holding majority control.

On January 1, 1953, Steel Corp. of Bengal was amalgamated with the Indian Iron & Steel Co. under the name of Indian Iron and Steel Co.

The Indian Planning Commission estimates that total requirements for steel in India will be about 3,000,000 tons in 1957. In addition, an additional 700,000 tons of iron will be needed, excluding that required for steel production. The three main producers of steel in India are: Tata Iron & Steel Co., Ltd., Indian Iron & Steel Co., and Mysore Iron and Steel Works. Present total capacity of these producers is about 1,900,000 tons of pig iron and 1,000,000 tons of finished steel.

It was reported during the year that six Japanese steel companies came up with a proposal to the Thailand government to build a steel plant there. Reports coming from behind the Iron Curtain indicate that a large steel plant has also been under construction at Anshan near Mukden in Manchuria. A heavy rolling mill, new seamless tube mill and blast furnace went into operation in 1953.

RAW MATERIALS

With the relaxation in demand, and the catching up of production, the problem of raw materials also became less acute in 1953. Steel, aluminum, copper, coal, scrap and most alloying elements saw delivery times markedly reduced. As the decrease in the shortages was accompanied by price readjustments, and elimination of premiums in many cases, lower costs should result.

Much work was done on developing new ore sources.

Test borings proved existence of large deposits of nickel near Moa Bay on the northeast coast of Cuba.

The problem essentially is a matter of balancing cheap foreign ores with high risk, against high cost domestic ores which have relatively little risk. As a comparison of the trends, it is estimated that by 1960, of the total shipments of 134,000,000 long tons of ore which will be required, about 55,000,000 long tons will be Lake Superior district direct shipping ores, and 22,000,000 long tons will come from the rest of the United States in direct shipping ores. To fill out the balance required, 37,000,000 long tons of foreign ores will be used and 20,000,000 long tons of concentrates. The same authority estimates that Lake Superior ore reserves total 2,200,000,000 long tons exclusive of low grade ores, and that low grade ores total 8,100,000,000 long tons of which 1,700,000,000 long tons are magnetic. From foreign sources, Canadian reserves total about 1,500,000,000 tons with a 50 per cent iron content. Venezuelan ore reserves are estimated at about the same figure, and Brazil's ore at about 4,000,000,000 long tons. Sweden has about 2,000,000,000 long tons, which will of course be primarily used in Europe.

The development work by the Iron Ore Co. of Canada during the year progressed at a rapid rate. Shipments will start late in 1954. Scheduled output is 10,000,000 tons annually, and this can eventually be increased to 20,000,000 tons.

Development work is also under way north of the concessions of the Iron Ore Co. of Canada by a group called the Fenimore Iron Mines. Their concessions are located on Ungava Bay. This deposit is close enough to tidewater to enable shipping by direct water shipments. Dutch and German steel groups are apparently interested in this project. Fenimore estimates a minimum tonnage of more than 550,000,000 tons of high grade iron bearing ores are located in their deposits. These are not direct shipping ores, but are mostly siderite which is a carbonate form of the ore which can be easily concentrated to about 60 per cent iron content.

Another project for mining and concentrating the Jasper ores in Michigan was authorized during the year by the Cleveland-Cliffs Iron Co. This operation will take place at the Republic mine where it is planned to set up a concentrating mill to provide an annual production of 400,000 tons of concentrates. Cost is placed at $26,500,000. Shipments from this mine should start in 1955.

Inland Steel Co.'s entry into the Steep Rock iron ore development will entail an estimated program of about $50,000,000 to be spent in 7 years. About 50,000,000 tons of ore are estimated to exist in Inland's lease. When in production, the mine is scheduled to ship 3,000,000 tons of ore annually.

Iron ore shipments from U. S. Steel Corp.'s Cerro Bolivar iron ore mine in Venezuela are scheduled for the beginning of 1954. Shipments for 1954 are estimated at about 2,000,000 tons, and by the end of the year should be running at an annual rate of 5,000,000 tons.

Another possible source of ore from Minnesota are the iron sulphide ores. A Bureau of Mines report released during the year indicates that several deposits of iron sulphide ores have been tested and they should give about 87 per cent recovery of sulphur. In addition a high grade iron oxide sinter suitable for blast furnace use could be recovered. This ore will thus furnish iron as a by-product only. These iron sulphide deposits may possibly be used in the development of a manganese supply in Minnesota through the use of sulphur dioxide gas. Laboratory tests indicate that the process has very definite possibilities.

An important source of iron ore for Europe is Sweden. This year about 78,000,000 tons of steel were produced in Europe outside of Russia. The most important single supplier of ore for these countries is Sweden who supplied about 15,700,000 tons. Sweden is also becoming a more and more important supplier to Great Britain. The United States also took about 2,500,000 tons which is about one-fourth of that imported into the states. Sweden is also developing additional supplies, and expansion is taking place in the Lapland fields. Ore handling equipment at Narvik, through which most of this material is shipped, is being increased to maximum capacity of 15,000,000 tons a year by 1956 as against present capacity of 9,000,000 tons. The open-cut workings in this area, known as the Kiruna workings, are running out and operations are going underground.

In 1952 there were 76 beneficiating plants on the Lake Superior range compared with 51 before the war. In 1951, 21,000,000 net tons of such ore were shipped or 24 per cent of all Lake Superior ore shipped compared with 3,000,000 tons in 1938. This type of beneficiation plant and product must not be confused with plants for concentrating and beneficiating taconites, a much more recent development.

It was announced during the year that a new beneficiation plant will be started at Eagle Mountain in December, 1953. This is the deposit which supplies Kaiser Steel. The new plant will raise iron content to 55.85 per cent.

The United States Steel Corp.'s Oliver Iron Mining

Co. tentatively selected a site near Two Harbors, Minn., for a $60,000,000 plant for treating iron ore. Before plans are definite, engineering studies must be completed. The Oliver Iron Mining Co. is operating iron ore plants at Virginia and at Mountain Iron, Minn. At Virginia, ores are pelletized and at Mountain Iron waste material is removed from the taconite. The first carload of taconite concentrates to be produced at the new experimental taconite beneficiation plant of the Oliver Iron Mining Division at Mountain Iron, Minn. was loaded on June 9, 1953. This shipment consisted of 60 to 65 per cent iron concentrates produced from taconite rock bearing only 25 to 35 per cent iron. Capacity now is about 500,000 tons a year.

Erie Mining Co. completed financing for its initial development of large scale taconite producing facilities on the Mesabi. Work has already begun on the project which is located at Aurora, Minn. The program will lead to taconite pellet production of up to 10,500,000 tons annually and will involve an investment of more than $300,000,000. Steel companies interested in this development are Bethlehem Steel, Youngstown Sheet and Tube, Interlake Iron Corp., and Steel Company of Canada. This company has been carrying on experimental work at a test installation in Aurora since 1948, and has processed more than 375,000 tons of taconite pellets since that time.

Reserve Mining Co., owned by Republic Steel and Armco, is developing a plant at Beaver Bay, Minn., which aims at an initial 3,700,000 tons pellet production by 1957. Eventual capacity of this plant will be 10,000,000 tons.

The Babbitt, Minn., plant of Reserve Mining Co. started mining their taconite field on the Mesabi Range. This plant can turn out 300,000 gross tons per year of 65 per cent iron concentrates. The ore to concentrate ratio is about 3 to 1. It is estimated it takes about 1.75 man hours to manufacture one ton of agglomerated pellets.

The scrap problem which has plagued the steel industries since the end of the war is now apparently eased. In addition, buying for extensive stock piles has largely disappeared. With the easing of demand, a better quality scrap is being received. Mill inspection is much stricter than it has been, and suppliers are much more anxious to make sure that downgrading of scrap does not occur.

The scrap market was erratic during the year, particularly in the last half.. The price of steelmaking scrap kept declining, and by the end of the year had dropped to as low as $33 a ton for No. 1 melting scrap and $29 a ton for No. 2 heavy melting scrap compared with prices up to $43 a ton early in the year. The decline may also be due to anticipated further drop in the steel production rate.

Domestic production of ferroalloys in 1953 exceeded the record high volume obtained in 1952 with a production of 2,300,000 net tons compared with 2,000,000 tons in 1952. One reason was that production of alloy steels totaled 10,300,000 ingot tons, the largest on record.

The expansion goal set by ODM for ferroalloy capacity stands at a total of 1,275,000 tons by the end of 1954. This was an increase of 511,000 tons over 1950.

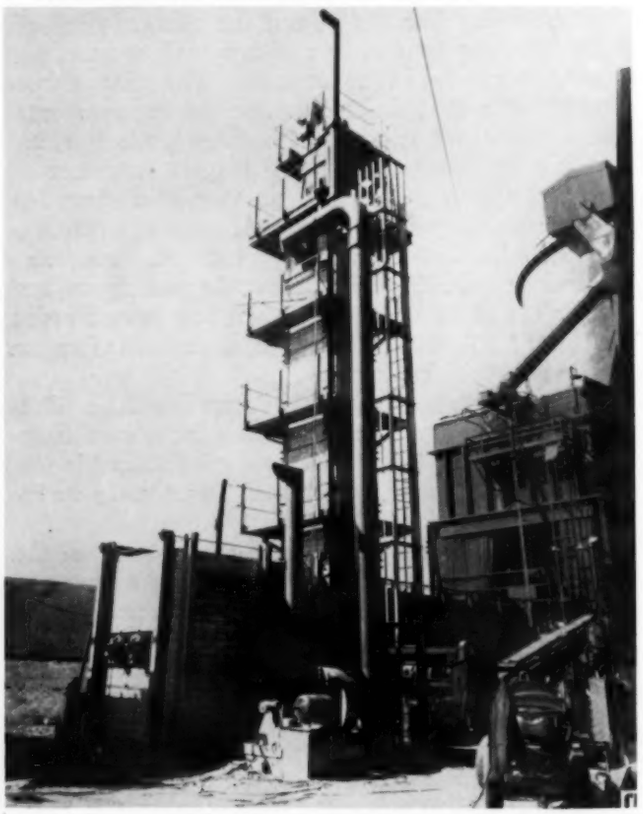
Test work continued on developing a process for the production of manganese from slag during the year. The pilot plant near Pittstown, Pa. was completed during the year. This plant is set up to handle 500 tons of slag daily to produce spiegeleisen having about 20 per cent manganese and 4 per cent phosphorous. The phosphorous is removed by selective oxidization in a basic lined bessemer convertor. The final remelting will then give a product having 80 per cent ferromanganese with phosphorous less than 0.35 per cent. The Bureau of Mines has estimated that the process can supply at least half the requirements of the steel industry for manganese.

The Bureau of Mines, in a report released during the year, indicates that substantial reserves of low grade manganese iron are located near Aitkin, Minn. It is believed that the material can be used for upgrading manganese deficient iron ores or for smelting to spiegeleisen. Tests made by the Bureau of Mines, however, on the manganese bearing ore from Aroostook County, Maine, indicate that these ores are almost impossible to upgrade by mechanical concentration. This discovery was reported on last year. Deposits here are estimated to have more than 266,000,000 tons containing 11 to 14 per cent manganese.

Brazil will become an important source of manganese ore with the signing by the United States during the year of an agreement which involves the supply of 5,500,000 tons of high-grade manganese ore over the next eight years. This agreement was tied in with an Export-Import Bank loan to develop rich deposits in the Amapa Territory.

A French firm named Comilog, in which the U. S. Steel Corp. has a 49 per cent interest, is preparing to

Char plant built by Colorado Fuel and Iron at Pueblo will age coal by reducing excess volatile matter. This improves coking. Plant shown is a pilot unit.



develop a large high grade manganese deposit located in French Equatorial Africa. There is estimated to be about 50,000,000 tons of manganese ore in this area. The mine is located about 250 miles from the coast. It will take several years, however, before the property can be made ready for production.

For the first time since the Korean War the end is in sight for the severe nickel shortage. The government let several contracts for metal to come from ore bodies that are too low grade to be developed under normal circumstances. The U. S. Government will pay the present market price for the extra nickel, plus an allowance of just under 29¢ a lb to amortize the new facilities. A number of similar contracts have been let by the Defense Materials Procurement Agency to meet a goal of 190,000 tons of nickel annually by 1955. Supplies already contracted for will deliver about 160,000 net tons of nickel by 1954 excluding the Nicaro Cuban project, a plant which was brought into production last year. Several U. S. sources are included in the plans. Nickel was decontrolled December 1, 1953, however, there still was a strong demand, and supply was short of all requirements.

Another new source of nickel was discovered in Cuba during the year near Moa Bay. It is estimated that this is a 40,000,000-ton ore body. Ore averages 1.35 per cent nickel. This is believed to be the second largest nickel deposit in the world.

Production of nickel by the free world in 1953 totalled 340,000,000 lb, an increase of 20,000,000 lb over 1952. Canadian output was estimated at 285,000,000 lb in 1953, or 85 per cent of the free world's total production.

Within the next two years, three new nickel refineries are expected to go into operation, two in the United States and one in Canada. Sherritt-Gordon, near Edmonton, Canada, should go into operation early in 1954 with an initial output of 9,000 tons annually to be derived from sulphide concentrates. Soon after that, it is expected that the National Lead Co. plant at Fredericktown, Mo., should be in production with a scheduled capacity of 1,000 tons also from sulphide. By late 1954, the Hanna Nickel Smelting Co. will have its electric furnace smelter in production on ferronickel in the nations first commercial plant in southwest Oregon. Capacity is estimated at about 9,000 tons of contained nickel. There is also a proposal under way under which the Nicaro plant will expand its production by 75 per cent. If these plans are approved, the new capacity should go into production late in 1955. Proposal contemplates increasing present 14,000 ton capacity to 24,500 short tons.

Softening of demand and availability of raw materials supplies in general resulted in drops in the prices of such items as lead, tin, zinc and copper. The sharp drop in tin price was sufficient to worry the producers in Malaya, and in some cases tin workings are being shut down, particularly the high cost units. This was also true for some of the high cost producers of the other metals.

For example, in 1952 world tin production was 168,000 long tons and world consumption was 128,000 long tons, which resulted in a large surplus of the metal. About 84,000 long tons were used in the United States in 1953. Several new uses are being found for tin. One of them is as an additive to titanium, for the addition of tin makes titanium weldable. Thus, as titanium uses develop they will require fairly large quantities of tin.

A new factor in the tin picture came up at the end of the year when the RFC announced that it may wish to dispose of some 40,000 tons of so-called surplus tin from their stockpiles. This announcement resulted in a drop of tin prices which had been on the upgrade just before the announcement.

About 10 per cent more copper was available in 1953 than the 1,445,764 tons which were delivered in the United States in 1952. This increase became possible because of higher imports and a larger volume of secondary scrap which was available. This increase in available copper is about 165,000 tons. If expansion projects continue as scheduled at the beginning of the year, an increase of 530,000 tons by 1956 is possible. Thus, by 1956, United States should have available as much as 2,000,000 tons. However, the relaxation in demand at the end of 1953 will probably result in cutbacks on some of the original proposed expansion programs.

The Wah Chang Corp. at Glen Cove, L. I., put into operation in November the first three of six new furnaces for the refining of tungsten. These are a radically new type and completely mechanized. This plant should help ease the tungsten shortage.

Primary aluminum production in 1953 in the United States totaled 2,500,000,000 lb or about 33 per cent over the 1,874,664,367 lb produced in 1952. A power shortage in the south reduced the total, which could have been somewhat higher if the power had been available. Primary aluminum capacity at the end of the year totaled about 2,840,000,000 lb including about 158,000,000 lb of stand-by capacity which uses high cost power. The third round of primary capacity expansion, which was announced late in 1952 and which would have brought three new producers into the industry has not materialized, and is still under consideration by the government.

Primary aluminum production in the United States in 1954 is expected to approach 2,800,000,000 lb or about 12 per cent more than 1953. When the additional aluminum capacity is completed, the five domestic producers will have a total productive capacity of 3,100,000,000 lb of primary aluminum.

The proposed project mentioned last year on the development of an Alaskan smelter by the Aluminum Co. of America was killed by the Canadian Government during the year. This extensive project in the Kitimat area of British Columbia, which would have involved an expenditure of half billion dollars, required diversion of the head waters of the Yukon River, which use was disapproved.

The Aluminum Co. of America started work during the year on a $4,000,000 modernization and expansion program of its ingot facilities at Cleveland. This program supplements the large Air Force heavy press plant which is under construction there.

A new process for making aluminum was in pilot plant production in France. This method involves dissolving silico-aluminum in liquid zinc at 1200 F. The zinc is distilled from the aluminum, yielding a high

purity metal. The process is known as Loewenstein process and the economies are not yet known.

Another new method is a continuous electrolytic process which can produce aluminum from low grade clays. Clay is first roasted and then put through a combination electrolytic and acid process. Many reagents are used which are, however, recovered in the process. The group sponsoring the process claims that costs should be 15 to 20 per cent less than the presently used Bayer process and electrical requirements are said to be less than 2 kwhr per lb of aluminum produced. This process has also been under test in a pilot plant which has been operating for more than a year in Europe.

Production of sponge titanium in 1953 was estimated at about 2250 tons. This is more than double the 1075 tons produced in 1952. There are only two important centers in the world for this, one at Henderson, Nev. and the other at Newport, Del. A Bureau of Mines installation at Boulder City, Nev. produced about 115 tons, and a Japanese company, Osaka Titanium, brought into this country about 20 to 30 tons of the material at $9600 a ton. Estimated requirements indicate that a minimum of 25,000 tons of such material should be made available in 1955, and other studies indicate that demand in time of emergency may be in the order of 1,000,000 tons a year. A new company, Cramet, was authorized by the DMPA to set up a 6000-ton per year facility at a cost of $25,000,000. The plant will be located in Chattanooga, Tenn., and should be in production by 1956. At that time, the two present installations should be able to produce about 3600 tons each, which will give a total of some 13,200 tons in 1956.

The Office of Defense Mobilization indicated at the end of the year that they expected to boost the output goal of titanium to at least 35,000 tons. This is an increase over the current goal of 25,000 tons by 1956.

Among developments, which have occurred in the titanium field, are that ingots have jumped from pounds to tons as 2-ton ingots are being made, continuous wide strip processing is a reality, reliable alloys are available in practically all the forms in which stainless steel is produced, and quality is being brought under control.

A new process announced for production of titanium dioxide was under test during the year in a pilot plant. Early cost estimates output price at less than $1.50 per lb compared with the present $5.00. The pilot plant consists of a single electrolytic cell. The commercial plant would consist of a battery of twelve cells making about 50,000 lb per year. In the process titanium dioxide is dissolved in a fused salt bath. The cell is sealed with an inert gas atmosphere mixed with a small amount of vaporized electrolyte. After electrolysis is completed, the electrolyte is tapped off to the level of titanium. The residual mixture is cooled and scooped out. This is not a continuous process, but a long run batch operation.

Tests made during the year have also shown that commercially pure titanium sheet can be successfully deep drawn. In drawing this material, the chief problem has been scoring due to pickup of titanium particles. Bonderizing and an application of a high pressure lubricant, as well as an electrolytic treatment, have been helpful.

During the year zirconium went into commercial production for the first time. This is being done in a plant which will have an annual output of 150,000 lb all of which will go to the Atomic Energy Commission. Another company also went into production on this material with an initial capacity of 120,000 lb per year. This plant may, however, increase production in 1954.

BLAST FURNACES

The construction of additional blast furnace capacity is a slower process than that of adding steel capacity, particularly in an existing plant. However, 1953, was a year which saw a number of new blast furnace units coming into production.

The Office of Defense Mobilization set a new expansion goal for blast furnace capacity during the year. Their revised goal is now 87,000,000 net tons annual capacity by January 1, 1955 instead of the 85,000,000 net tons which had been set previously. As a result of this expansion, the target was extended back one year from January 1, 1954. No ferro-alloy capacity is included in this figure although it does include pig iron for castings.

The third Kaiser furnace is practically identical with the first two furnaces at Fontana. These furnaces have been operating with record low coke consumption rates and so satisfactorily that the same design has been reincorporated in the third furnace.

However, several minor innovations and changes were made on this third furnace by Kaiser. One is a decrease of 5-in. in the big bell diameter. Pyrometic cone 23 or the hardest commercial available refractory brick was also used. It is expected that this will last longer than that in the other furnaces where cone 14 had been used previously.

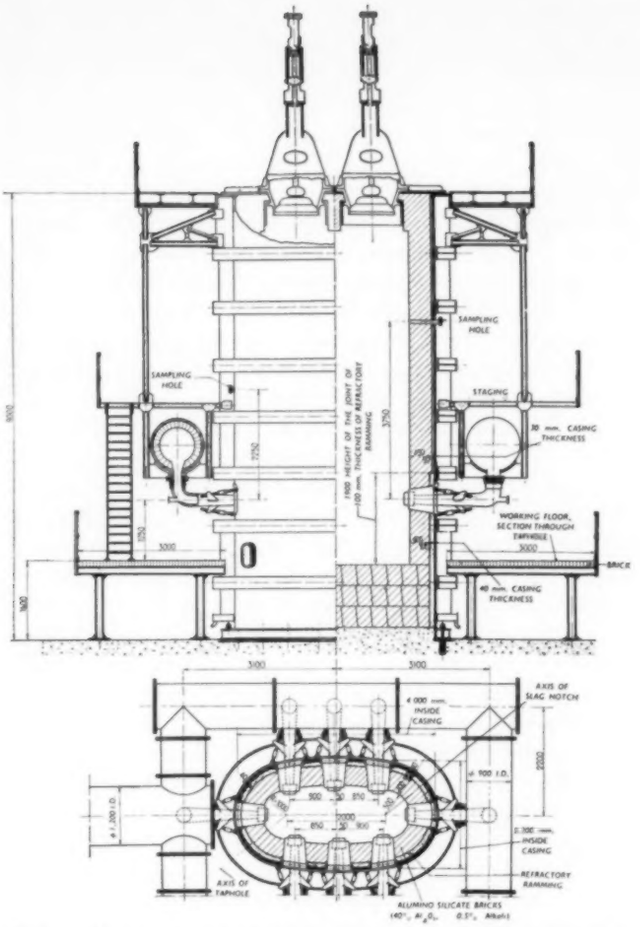
It is reported that Kaiser Steel's blast furnaces at the Fontana works produced at an average daily rate of 1335 tons of pig iron during 1952 while being rated at only 1200 tons per day. Coke consumption is given at 1409 lb per net ton of iron compared to a national average between 1600 and 1700 lb.

Great Lakes Steel Corp.'s new blast furnace for its Zug Island plant near Detroit, on which construction will start early in 1954, may be larger than any others now in operation.

One of the largest blast furnace turboblowers ever built in this country was installed in Armco Steel Corp.'s new blast furnace. This is a 5-stage unit with a rated capacity of 121,000 cfm of air at 35 psig discharge pressure. It is driven by a 15,220-hp, 2500-rpm, 16-stage steam turbine. Steam conditions are 400 psi, 750 F with 28-in. vacuum.

A new detector was developed during the year for locating tramp metal in ore, regardless of magnetic properties. The device works on the differential measurement of the energy absorbed by ore and the tramp materials.

The largest blast furnace ever built in Great Britain was blown in at the Hawarden Bridge steel works of John Summers & Sons, Ltd. This firm has also a second blast furnace under construction at this plant. When operating on high-grade ore, production is rated at 1200 tons per day, and with home ore at about 1000 tons



Plan and side elevation of low shaft blast furnace installation built in Europe for a test program.

per day. The furnace is equipped so that it may be used eventually for high-top pressure operation.

There has been continuous adoption of use of high top pressure operation in blast furnaces in Europe, and at the present time at least six blast furnaces in Western Europe and the British Isles are being used with pressure operation or being converted to its use.

What is reported to be the largest blast furnace in Europe is under construction at Westfalenhuetter A. G. plant, Dortmund, Germany.

An unusual installation of blast furnace charging equipment was installed at the Seraing, Begium steelworks of Societe Anonyme John Cockerill. This plant is located in a highly congested area. The solution was a more or less automatic conveyor type materials charging system. After the ore and coke leave the hopper storage near the blast furnace, charging of furnace is controlled by new timing arrangements. Timing is set by a cam-controllor actuated through clutches by a selsyn motor. A 220-yd long conveyor belt is used, traveling at a speed of 3 fps. This belt carries 1200 tons of ore and 400 tons of coke every 24-hr to charge the furnace. The coke is released from the hoppers by vibrators. Ore comes from the hoppers by a manually controlled electrically operated scale car. Steel plate conveyors, which are actuated by the central timing device, deliver the charges from the scale car to the conveyor belt. By properly setting up the operating switches, various sequences of coke and ore charges can be used on either of two furnaces. The conveyor belts can charge independently any one of the three new furnaces.

The arrangement for charging at this location, however, was primarily dictated due to conjestion and may not be economical on other situations.

A new method for distributing the raw materials in blast furnaces was discussed at one of the technical meetings during the year. One company has developed and is using a spinning top on five of its six furnaces. Essentially, the unit incorporates a tall, slender hopper which reduces amount of stock piled on one side, and while the skip is dumping ore into the small bell hopper, one complete revolution of the hopper is normally made. Hoppers rotate at about 26 to 28 rpm, and excellent distribution is obtained. Principal change is, of course, the idea of spinning the small bell hopper rapidly and continuously while the skip is dumping. The general mechanical design used is as on all modern tops. As a result of the new hopper, increased pig iron production was attained at a lower coke rate and with less flue dust. Production increases of 15 to 20 per cent were claimed, and coke consumption was reduced about 75 lb per ton of pig iron. Flue dust decreased more than 250 lb per ton of pig iron. Volume of air was increased by about 10,000 cfm.

Parts of the operation of the blast furnace are being made more automatic. Program control which indicates need for certain operations or which actually initiates such operations has been put into operation on three new furnaces at Crucible Steel, Midland, Pa., Detroit Steel at Portsmouth, Ohio, and Dominion Foundries and Steel at Hamilton, Ont. Coke hoppers are placed on either side of the skip pit. Coke is automatically charged into the skip using either weight or volume control. While the coke is being discharged, the scale car operator can load the car with ore or limestone. This avoids what was once a bottleneck. A panel is located high enough so that the scale car operator can work it, and this indicates to him the position of the skips, the furnace stock level, and the next item due to be charged. Once he dumps his car into the skip pit, a push button starts the skip, accelerating it at the start, decelerating it as it approaches the dumping horns and stopping in discharge position. In this way, the whole charging operation is coordinated so that all items take place at the proper time in the proper sequence with the proper amounts. One or two operators can do the whole charging operation.

Another new control holds the blast air temperature within very close limits by an arrangement which uses a potentiometer and a pneumatic proportional control unit with a single mixing valve. This close control of air temperature which can be held from 3-5 degrees F will give much more uniform iron analysis. Temperature variation is held 25 F during stove changes.

Split wind blowing is also gaining favor and one furnace in the Buffalo district and one furnace in the Chicago district were being equipped with such blowers during the year.

Hanging and slipping in blast furnaces have been reduced by means of an automatic control. Control is based on differential blowing and, on units tried, practically eliminates hanging and slipping in the furnace. Differential blowing has been tested on both merchant

and basic type furnaces. From observations to date, basic furnaces should be easier to control than those working on hotter iron.

Work on the continuous analysis of blast furnace top gases has shown that this may provide a very useful tool for blast furnace operators. Continuous analyses are made of CO, CO_2 and H_2 which are fed into an electronic computer which calculates a gas index. Significant changes in gas chemistry can reveal corresponding changes in iron chemistry which will not occur until several hours later. In the meantime, it is possible to make furnace adjustments to give the required furnace chemistry. The instrument uses thermal conductivity differences to measure volume percentages of the gases. The measurement of the gas content depends on differences in thermal conductivity of the gas before and after absorption of one of the constituents.

As a result of this instrumentation, the hydrogen alarm for detecting water leaks in the blast furnace was developed. The use of this alarm enables leaks to be detected and repairs made, sometimes within minutes. The alarm works on the principle that a leakage of water to the furnace will raise the corresponding hydrogen content of the top gas.

The No. 10 furnace at Gary has been watched with a great deal of interest by blast furnace operators. In this furnace the carbon lining was extended from the bottom of hearth staves to 35 ft above the mantle. When this was put in, it was done with the thought this height of carbon might be even higher than was desirable, but it was felt worthwhile to make a test. In locating the carbon, the major principle was that the carbon should be restricted to the water-cooled walls only, and to a thickness which could be effectively cooled with no intervening fireclay brick, coke breeze or other insulation between the carbon and the shell. When rebuilding this furnace, it was changed from a 12 to a 16-tuyere furnace with additional stove capacity provided. The lower part of the hearth is cooled by conventional cooling staves; but the tuyere jacket was modified to give in effect additional cooling staves extending 2 ft above the centerline of the tuyeres. In addition, heavy steel plates completely encircling the jacket were welded and provide additional strength.

Operators report that the furnace operates very smoothly with almost complete absence of slipping or hanging. Furnace seems more sensitive to heat and wind changes than normal for ceramic lined furnace. Contrary to the plant's usual practice of four casts per day, the furnace is making five casts. Attempts to get a four-cast schedule have resulted in burned monkeys which indicates that the hearth bottom is not cut out as is usual. Thermocouples were installed in a number of places in the furnace. However, some trouble has been had with these since deposits of chloride have eaten through some of the couples.

There has been no indication to the present time of any build-up on the walls. No slips have carried cold stock into the tuyere area. There has been no appreciable loss in lining thickness. Thermocouple readings are constantly being made as a check on the lining condition. Operators have confidence that the carbon lining in the bosh and hearth will continue to give the increased capacity and smoother operations which they feel outweigh the higher initial refractory cost.

In Europe stack linings of carbon have been tried with rather mixed reports. In the United Kingdom operators have also been trying china clay for this purpose. This is a constituent of decomposed granite. The material when fired to 2730 F is known as molochite. Ball clay for bonding has come from the same source. China clay brick should have a bulk capacity of 130 lb per cu ft. The iron content does not exceed 1 per cent and this must be finely disseminated. In the latest developments, the molochite is bonded with china clay itself and dry pressed. Care must be taken in safeguarding the material against tramp iron. One furnace, recently placed in operation, has already made 60 per cent more iron on this type of stack compared with firebrick, and it is hoped to reach 100 per cent. The cost is three times that of good firebrick. A lining of this type was installed in one of the 20-ft furnaces at Corby, England several years ago and is still in operation.

The results of an investigation sponsored by the AISE during the past couple of years at Columbia University were reported on at the AISE fall convention. This study was undertaken by computational methods to determine the freezing lines of iron in blast furnace hearths of several different designs. The results of this investigation showed that different types of linings had different locations for the freezing lines, and that the best freezing line was definitely dependent upon the hearth design. The investigation should result in data which will enable the designer to so detail his furnace to minimize hearth breakouts.

The initial work, based on the most probable assumption that the salamander space is filled with iron, indicates that carbon linings, especially for sidewalls, appear superior to ceramic linings. The work also shows that the best lining construction depends on the diameter of the furnace. All work done so far is limited to furnace with a 28-ft diameter.

One definite trend in blast furnace construction has been the installation of equipment to cut down the flue dust and dirt produced by the furnace. An example of this trend was the work done by Pittsburgh Steel Co. on their No. 3 blast furnace at the Monessen works. This furnace was relined and remodeled during the year, and new equipment includes gas cleaning equipment of the electrostatic type and new slag handling methods which prevent the release of fumes or obnoxious odors during the granulating process. One unit in their clean-air program is a gas mixing station which combines gases from the blast furnace and coke ovens to give a usable, uniform fuel. Previously, much of this gas was discharged to the air. System also has saved about 1000 tons of coal per day, and eliminates smoke also produced by this coal.

U. S. Steel Corp. placed into operation July 16 a new ferromanganese cleaning plant at its Duquesne works. This plant is the first of its kind and was particularly designed to eliminate the dust peculiar to ferro operations. Unit includes five electrostatic precipitators which have a combined capacity of 135,000 cfm. Auxiliary equipment includes facilities for handling and disposing the dust. Flue dust contains about 18 per cent manganese and is being stockpiled at the present time,

and economical methods for recovering this ferromanganese are now under test. In addition to the benefits from the elimination of dust and fumes from the atmosphere, there are additional improvements in operations in the plant through the use of clean gas in the plant boilers.

The No. 3 blast furnace at the Duquesne works was also completely equipped with electrical controls which will automatically charge the stack.

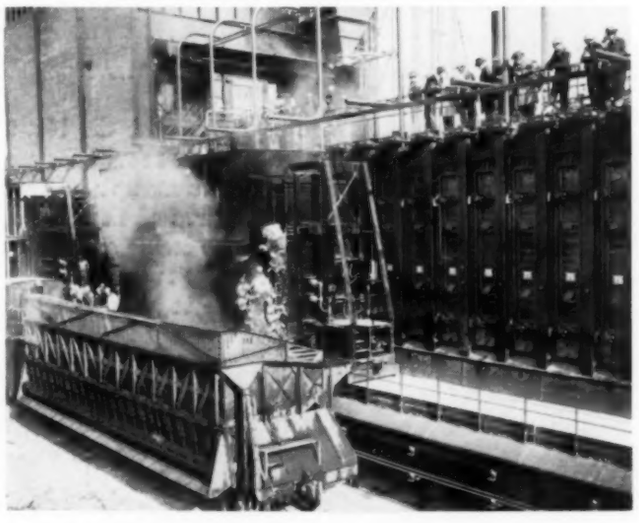
A new development for electric precipitators is a solenoid-actuated magnetic impulse system which cleans precipitators in 60-second cycles. Equipment can be installed on any standard precipitator unit used with electric, blast or open hearth furnaces.

Another operating procedure reported on during the year was that of blowing in a blast furnace through the iron notch. Applying the blast through the tap hole apparently reduces blow-in time. After blowing into the tap hole for about six hours, the tuyeres in the front of the furnace are opened one at a time, and the blast volume is increased to hold a 10 to 15 psi blast pressure. The remaining tuyeres are gradually opened as conditions warrant. By following this procedure, the time of returning a banked furnace to 80 per cent normal blast has been reduced from about 72 to 30 hours.

Thermocouples are being used more and more in furnaces to control the drying, as it is realized that serious damage has been done during the drying-in periods and some of the premature hearth breakouts may have been due to such drying practices.

With the approval of the Organization for European Economic Cooperation, a directing committee for international research on the low-shaft blast furnace was appointed, consisting of representatives of seven countries, Austria, Belgium, France, Greece, Italy, Luxembourg, and the Netherlands. This group has designed a low shaft experimental furnace for an output of 80 tons a day which was scheduled to go into operation in 1953. This furnace was built to utilize low grade ore and does not require a metallurgical coke. The furnace is designed to use a maximum oxygen enrichment of 50 per cent and thus would use about 45 tons of oxygen a day. The design is oval shape, about 10 ft in diameter. The oval shape of this furnace is new.

Jones and Laughlin Steel Corp. started their new 79-coke oven battery at their Pittsburgh works on December 2.



Sponge iron production, although probably not practical in the United States, is finding more favor in some parts of the world. This production is now chiefly centered in Sweden and Mexico. Production now is about 50,000 tons per year and it appears that it will reach a level of about 200,000 tons per year within the next few years. The first tunnel kiln sponge plant in operation on this continent is at the steel plant of Hojalata y Lamina in Monterrey, Mexico. The entire output is being used to make rimming steel for rolling into sheet in standard electric steel furnaces. Sponge iron is produced cheaper than scrap at this particular location. The capacity of the kiln is about 10,000 tons per year. Plant has been in operation since 1952.

The increase in the use of sponge iron in Sweden is apparently due to the conclusion which has been reached there, that sponge iron is a more satisfactory substitute for charcoal pig iron than coke pig iron would be in the manufacture of steel. Under Swedish conditions, the cost is also lower.

It is interesting to note that over half the blast furnaces in Sweden still operate on charcoal, although three-quarters of the pig iron tonnage produced is from coke. Advancements in operation have, however, reduced the requirements of charcoal per ton of pig iron to about 1600 lb compared with more than 2400 lb at the beginning of the century. At the Domnarvet plant of Stora Kopparberg, they have brought their coke rate down to 1450 lb per ton of pig iron.

However, a number of sponge iron plants in Sweden are of the Wiberg-Soderfors type and at least four plants with an annual capacity of 20,000 tons are under construction. This is a continuous process and requires about 500 lb of coke per ton and 1,000 kwhr of electricity. Sponge is also being produced in Sweden by the Hoganas method. Formerly, this has been a batch process, but a new continuous plant is under construction which will have a yearly capacity of about 30,000 tons. Most of this will be used in iron powder metallurgy.

Another sponge iron plant that went into operation during the year is the Krupp-Renn kiln built for the Dominion Iron and Steel Corp., Ltd., at Airlie, South Africa. This went into operation in the spring of 1953. Another Krupp-Renn plant was erected at Abiles, in Spain.

At the Norwegian Mo-i-Rana plant, a new Tysland Hole electric pig iron furnace was put into operation this year. These furnaces smelt a burden of concentrated and agglomerated domestic ores and have nearly twice the capacity of any previous units or 220 tons a day. Coke consumption per ton of iron will be less than half that of a normal blast furnace, and in addition, furnaces will use a mixture of ordinary gas coke and coke breeze instead of high quality metallurgical coke. Each ton of pig iron made will produce about 20,000 cu ft of 270-Btu gas which covers all the reheating requirements at this integrated plant.

Republic Steel Corp. developed a new process for the production of powdered iron and authorized the construction of a new plant in Toledo, Ohio for the production of this material. Capacity will be 50,000 lb per day. Republic thus becomes the first of the country's major steel companies to go into production on this material. Details of the process are not available.

During the year the Office of Defense Mobilization announced that the expansion goal for by-product coke oven capacity was revised to call for an additional 1,800,000 net tons capacity annually. This sets the goal at 85,800,000 net tons by January 1, 1955. The original goal has provided for an annual capacity of 84,000,000 by January 1954. This increase in coke plant capacity was a result of their increase in the expansion program for pig iron.

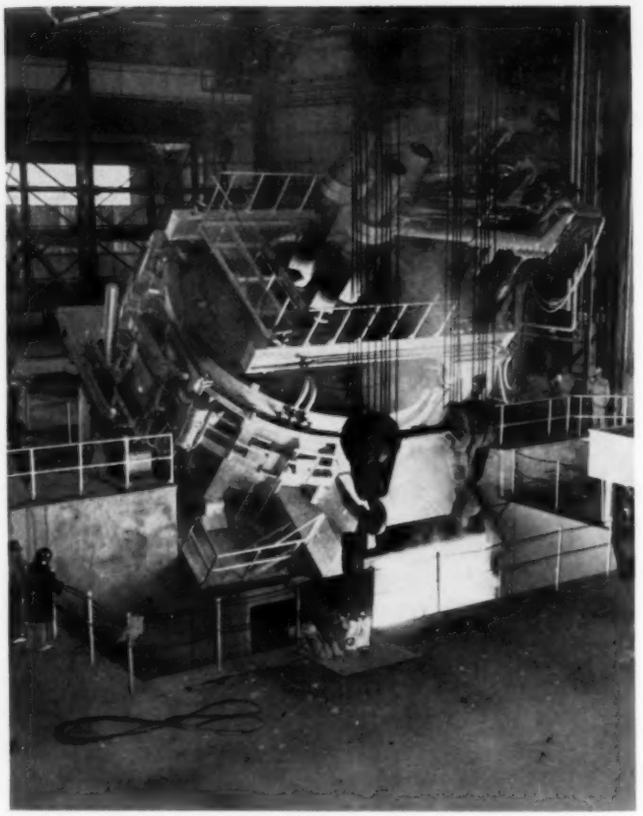
The Colorado Fuel & Iron Corp. put into operation a char plant. Fundamentally, the operation of such a plant is to age coal by several million years in a very short time. In other words, units are actually low temperature furnaces which remove part of the excess volatile matter from the young Colorado coal, leaving a low volatile coal. This char is then blended with coking coal, improving the quality of the coke which is used later in the blast furnaces. About one ton of coal per hour is handled by the furnace to produce 1600 lb of char. This plant is a pilot unit and it is too early to estimate the effect that this plant will have on the actual operations.

A process for utilizing the vast lignite and sub-bituminous coal reserves as a source of power and coal tar products was described by the Bureau of Mines. The fuel derived is expected to compete with natural gas at prevailing prices. Known as coal carbonization in a fluidized state, the process is a low temperature carbonization which yields a char of high heating value for power plant use, as well as crude primary coal tar which can provide a future source of by-products which normally come from coke oven tar.

STEELMAKING

Present ingot capacity proved to be ample by the end of the year when operations were cut back appreciably at a number of plants. As a result of the slackening in demand, some of the more obsolete open hearth and other units were closed down, some perhaps permanently. Among these were the five remaining open hearths at the No. 1 shop of the Duquesne works which had an annual rated capacity of 375,000 tons. The loss of this capacity at Duquesne was offset by increase of 200,000 tons annually in its No. 2 shop and an additional 160,000 tons at an electric furnace shop.

There was a great deal of discussion during the year on the future of the various types of steelmaking furnaces, open hearth, bessemer and electric. These discussions usually concluded that the electric furnace share of making steel would become more and more important as time went on, and that under certain conditions of location, raw material prices, and investment costs, would prove to be the more economical way of making steel. In spite of these discussions, the cut-back in production during the year hit electric furnace capacity worse than the other methods of making steel. For example, in the month of November when the industry ran at 90.1 per cent of capacity, electric furnaces were operated at 48.3 per cent, bessemer at 74.2 per cent and open hearth at 94.9 per cent, compared with 81.2, 88.9 and 101.4 per cent in January of 1953. Reduced operation in electric furnace steelmaking was expected to continue into the first quarter of 1954. Part of this reduction is due to corrections in current inventories, as



The electric furnace was the topic of a great deal of discussion during the year. Some operators feel that it can compete economically with the open hearth.

hoarding had been most widely practiced with the type of steels made in the electric furnaces.

Although the various studies made during the year indicate that the 200 to 250-ton open hearths are the economical unit, one steel producer believes in large furnaces, and now has nine or more 500-ton or larger furnaces in operation.

Six basic open hearth furnaces which were rebuilt at the Gary works of the United States Steel Corp. had their design so changed that they had 32.4 per cent less uptake area and 25 per cent more hearth area than other similar furnaces in the plant which were left unchanged. These rebuilt furnaces, whose hearths were extended from 48 to 60 ft, gave improved roof life, increased production rates, and reduced average tap-to-tap time. Average tons per hr produced was increased by as much as 7.8 per cent, and roof life was up 18 per cent over the conventional furnaces. Fuel consumption was about the same.

On the other hand, it was reported that the No. 2 open hearth at the Ford Motor Co. was rebuilt from a double uptake to a single uptake, with an uptake area of about 35 per cent less than the area of the double uptakes. Basic brick was used in the inside surface of the uptake walls with silica brick on the outside. Arches were also of silica brick. The change to single uptake allowed a saving in cost of approximately 20 per cent for the material on that portion of the furnace uptakes from the ground to the roof skews. There were about 34 per cent fewer 9-in. equivalents required to build the uptakes. Detrimental effects of the change were reported, however, in that fewer tons per hr were made and fuel consumption was increased. This is thought

to be due to the loss in regenerative capacity of the four walls as compared to that of the previous eight.

A meter developed by the British Iron and Steel Research Association measures open hearth furnace pressure and can be installed close to the measuring point on the roof. This eliminates errors due to buoyancy effects in connecting pipes. Meter is of differential-pressure type.

Installation of instruments for quick precision analysis of steel for production control is also finding increased acceptance. Crucible Steel Co. installed two such units during the year. Detailed analysis can be obtained in about ten minutes. One of these instruments is installed at the Syracuse works and can be used for chemical analysis of tool, high speed, stainless, low alloy, and high temperature alloy steels. At Midland, Pa., where the other unit is installed, it is chemically equipped to analyze stainless steel, alloy and pig iron.

A new densitometer comparator has been developed which measures the lines on a spectrographic plate. Thus the composition of inorganic materials may be determined quantitatively, in only a minute or two, as compared with several hours by ordinary methods.

Hydrogen is known to have a detrimental effect on steel because of the effusion which may take place at room temperatures. One company has developed a method for determination of hydrogen in steel forgings by a warm vacuum extraction and mass spectrometer analysis, and this gives a good method for checking such steels where this is a requirement.

Chemical cleaning of open hearth checkers during the operation of the furnace has been well received, and has resulted in improved operating efficiency and reduced fuel and maintenance costs. The process consists of pumping chemical solvent solutions at 2500 psi through jet nozzles. Cleaning operation can be completed in 2½ hr in small furnaces, and time goes up to 11 hr for large furnaces of 400 tons. Downtime is greatly reduced and tonnage output has been increased.

Another plant is cleaning open hearth checkers and sewers during operation by using a combination of water and compressed air. The air at 80 psi drives a slug of water down into the flue, and if the flue is plugged, the water hits the hot flue dirt, is converted into steam, and with the minor explosion or pressure built up, drives the dirt out of the flue. Checkers should be hot to get the best results and care must be taken not to cool them by using too much water.

Checkers are also efficiently cleaned by means of a tube cleaner which consists of a motor on a shaft, on the other end of which is a group of three chains, which when rotated by the motor, beats the material off the sides of the tubes. Square holes can be easily cleaned with this unit.

Blasting has become a regular operation in some open hearth shops to remove open hearth slag. The big advantage in the blasting process is speed, and it also requires less labor. Where previously it may have taken from 12 to 24 hours to remove the slag, it can now be removed in from 6 to 8 hr. One of the secrets in the process is to minimize the time from start of charging the holes to the actual blast, because of the heat involved. So far there have been no premature blasts.

Explosives are also being used in the removal of furnace linings. This method also offers possibilities of reducing furnace downtime.

Inspection of scrap bales, usually by dynamiting a number, has had several beneficial effects. It enables the operator to find contaminants in the scrap which would not be otherwise noticed, and better scrap seems to have been shipped after the practice started.

Advantages are claimed for monolithic linings in tapping spouts. Operators reporting on this state that the monolithic-lined runner expense is 62½ per cent less than that of the former brick lined runners, and the runners have an average life of over 500 heats. Other advantages of the monolithic refractory spout over the conventional brick lined type are easy removal of skull, easier lining, quicker drying and less crane handling. Cost for a typical one was reported at $264 compared with $42 for the brick lined spout. On the other hand, the cost per heat was only 8¢ in favor of the brick lined spout, and other factors more than offset this slight difference.

The work on top-blowing with oxygen which started originally in Austria, has resulted in the building of 30-ton convertors at both Linz and Donawitz plants. The one at Linz is now in regular operation. The vessel is a converter of rammed dolomitic magnesite with a blank bottom. Refractory life is at least 120 heats for the walls, and the bottoms outlast several wall linings. The 98 per cent oxygen at 4 to 12 atmospheres pressure feeds through a water-cooled copper nozzle placed vertically above the melt at a distance of about 10 in. Scrap, averaging about 15 per cent of the charge, is charged at the beginning. Thermal efficiency is about 70 per cent. Oxygen consumption runs about 2000 cu ft per ton of steel. Final steel is excellent for deep drawing and has analyses showing no more than 0.003 per cent nitrogen and less than 0.035 per cent phosphorus.

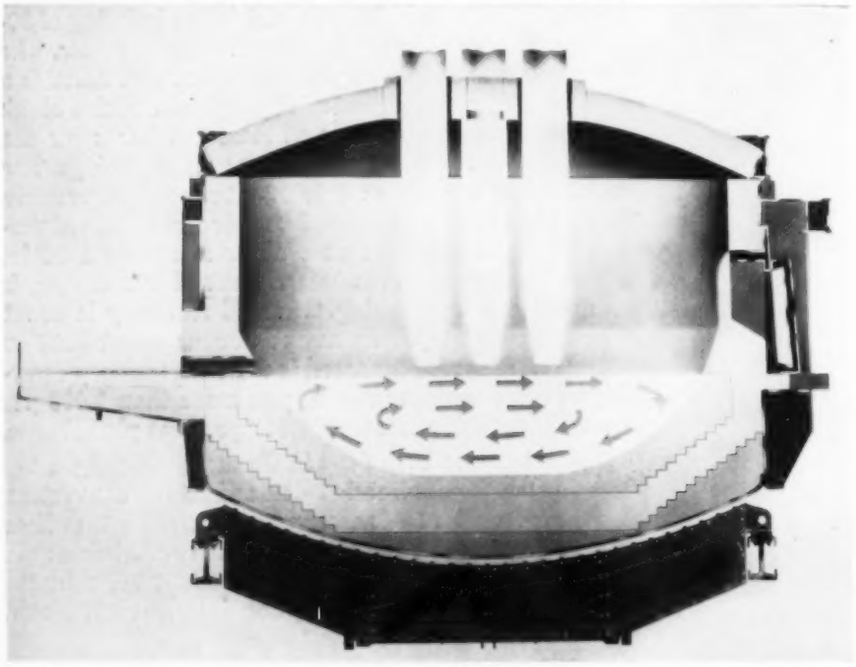
Work has also been done in Germany on oxygen top blowing of Thomas iron in 3-ton and 25-ton converters. The work on the 25-ton converter indicates that lime should be added at two stages, about two-thirds at the beginning and the remainder after about 7½ minutes of blowing. Oxygen consumption is about 2300 cfm. Blowing time is about 22 to 25 minutes.

Dominion Foundries & Steel, Ltd. signed a contract during the year for the construction of the first furnace in North America which will use this new process for making steel. This process utilizes a converter similar to the Thomas converter and oxygen is blown in at the top. Dominion is also building a plant to furnish the oxygen. McLouth Steel is considering this method of making steel. Their steel will, in general, be used as hot metal in their new electric furnaces. In addition to McLouth Steel and Dominion Foundries and Steel, Ltd., it is understood that several other companies in the United States are investigating top-blowing oxygen in converters.

A number of other European bessemer plants are also now using oxygen enrichment which gives 30 per cent O_2 in the final blast in their bessemer furnaces. Results compare with the carefully controlled scale or ore-blowing process. Blowing time is reduced 30 to 40 per cent and output is increased from 15 to 20 per cent. All the economic advantages of the basic bessemer process are retained. In some plants, an oxygen-steam

mixture is used, and when this is done, the nitrogen is reduced to a maximum of about 0.0025 per cent.

The last year saw a rash of studies concerned with comparative costs of electric and open hearth furnace steel and on the production of carbon steel in large basic electric furnaces. The impetus in the adoption of electric furnace units, which started in World War II when electric furnace capacity was 1.9 per cent of total steel capacity, has carried them to about 9 per cent of steel capacity at the present time. By the end of 1953, electric furnace capacity exceeded 10,200,000 net tons. Most of the growth of electric furnace capacity was for the purpose of producing alloy steels. With the drop-off in alloy demand after the war, a number of operators who had surplus electric capacity started producing carbon steel ingots. Their experience showed that carbon ingots could be produced economically in such electric furnaces, and the result has been a trend to the manufacture of carbon steel in such units. Since 1946, carbon steel produced in electric units has exceeded alloy output every year. In the first half of 1953, carbon steel comprised about 52 per cent of steel made in electric furnace units.



Several new applications of the induction stirrer were authorized during the year. Stirring action can be directed in either direction by reversal of the magnetic field.

Practically all the new electric furnace units are top charge units. Top charging plus increased voltages and transformer capacities have been the factors which brought electric furnaces to the fore. The electric furnace also, because of the lower capital investment has been in favor with the small independent unintegrated steel plants. For example, all five of the new companies added to the list of steelmakers in 1952, operate electric furnaces exclusively for producing steel. All are small producers. Of the total 86 steel producers in this country, about 60 make electric furnace steel, and 42 use electric furnaces exclusively.

A very interesting study on electric furnaces versus open hearth furnaces in cold metal shops was presented at one of the American Iron and Steel Institute meetings during the year. This paper summarized well some of the present discussions on the subject. It stated that the higher thermal efficiency of the electric furnace compensates for more than half the higher price of the electric energy over heat energy from fuel. This study concerned itself only with 250,000 and 500,000-net ton annual capacity shops. For such shops, the study showed that the operating cost of electric furnaces is about $4 per ton of ingots, higher than that of open hearth furnaces, and the material cost is about $4 per ton less for electric furnaces than for open hearth steel, based upon Pittsburgh prices for pig iron and scrap. If cheap scrap is available, the material cost of electric furnace steel may be as much as $8 to $9 per ton less than for open hearth steel. For cheap pig iron, material costs for the two processes are about equal. Also the installation costs and capital charges of electric furnace shops are about 60 per cent that of open hearth shops of similar capacity. Thus, the overall cost of ingots after fixed charges is $2.60 to $4 less from electric than from open hearth furnaces with Pittsburgh prices for pig iron and scrap. With cheap scrap, the cost of ingots may be $7 to $8 less from electric than open hearth furnaces. On the other hand, in evaluating this study, one must realize that the cost of steel in integrated shops may be much less than for the relatively small sizes used in this study.

Interest in the electric furnace was also stirred up during the year as a result of a report comparing electric and open hearth furnace operations prepared and issued by the Battelle Memorial Institute. This report was sponsored by a group of private electric power companies and coal interests. Report was based on plants having annual capacities of 250,000, 500,000, and 1,000,000 tons. Among the features pointed out is that the capital cost of electric furnace installation is only 60 per cent that of the open hearth, and the cold melt steelmaking process shows lower cost for the electric furnace, with the result that the electric furnace shows a greater annual return on the investment. When 50 per cent hot metal and 50 per cent scrap are used, the annual return on invested capital with the electric furnace is equal to that of the open hearth. Other favorable aspects of the electric furnace which were pointed

out is that the electric furnace is more flexible and can be kept in operation a greater percentage of the time. In addition, the yield is about 2 per cent greater.

In another technical paper presented during the year, it was predicted that the output of electric furnace carbon steel ingots by 1975 will rise to 30 per cent of the total carbon steel ingots produced. The prediction indicated that 162,000,000 tons of carbon steel would be produced in 1975, of which 43,000,000 tons would be made in electric furnaces.

It is interesting to note that in Sweden, over 40 per cent of their steel production comes from electric furnaces. Most of Sweden's electric furnaces are the arc type, but high frequency furnaces are being installed more and more at various plants. At Bofors, high frequency furnaces are in operation handling charges of 10 tons and more. Such furnaces have certain advantages for the production of high speed, stainless, and refractory steels.

Operations are being tested in the electric furnace on the practicability of using hot metal. As a result of the experience of a small eastern steel plant which used iron with about 3.5 per cent carbon during the war, and reduced it to 20 points in about 1½ hr with the addition of iron ore, a number of other plants are experimenting with the method. However, a few plants which recently tried a 100 per cent hot metal charge, found that charges with up to 50 per cent hot metal seem to work much more effectively. The expansion of the electric furnace, as some of its advocates seem to believe, will depend to a large degree upon the development of methods which will enable the electric furnace to utilize hot metal in its operation.

The largest electric furnaces under construction in this country are destined for McLouth Steel in the Detroit area. These furnaces have a 24-ft 6-in. diameter, and are equipped with 25,000-kva transformers which have heat exchangers to increase their rating to 33,300 kva. Maximum holding capacity will be about 200 tons. It is believed that these furnaces will be charged with about 50 per cent blown metal having about 0.6 per cent carbon, which will come from the basic converters equipped for blowing oxygen on the top of the bath. One of the unusual features of these electric furnaces is that it will be possible to tilt the furnace with the roof off as well as on. The equipment is so set up that it is possible also to lower the electrodes through holes in the floor.

As a trend to top charge, two 70-ton electric furnaces in the Canton, Ohio, area are to be converted from side door to top charge operation. In addition, transformer capacity of one of these units is being converted from 12,000 to 20,000 kva. The other one was already 20,000 kva. One of these furnaces will also be equipped for induction stirring.

One electric furnace plant on the west coast has found the use of mullite to be advantageous in the roofs of its electric furnace. Life of roofs has been increased to about 322 as against a previous average of 112.4 with silica special shapes. An indirect effect of the use of the mullite has been increased lining life on the basic side walls. This increase has been attributed to fewer spalls and less running of silica roof.

Tests were completed during the year on the smoke

The production quantometer shown was installed at Crucible Steel's Sanderson-Halcomb works. From left to right can be seen the recording console, spark stand, diffraction grating and the power source unit.

control equipment put into service on Bethlehem-Pacific's electric furnace at Los Angeles. The electric furnace at this plant has been equipped with electrostatic precipitators to give removal, at better than 90 per cent efficiency, of the particulate matter from the furnace. This installation uses a hole directly in the furnace roof and a powerful suction system to draw gases into the precipitator gridwork.

The electric precipitator seems to be the coming unit in the cleaning of fly ash and particulate matter from electric furnaces, open hearth and blast furnaces. They are used on the open hearths at the Fairless plant of the United States Steel Corp. at Morrisville. This is the first time electric precipitators have been used on open hearths in the eastern part of the United States. Two units are installed on each of the nine furnaces. They are about 48 ft long, 38 ft wide and 38 ft high, designed to remove more than 95 per cent of dust normally in the open hearth exhaust. On the west coast, Columbia-Geneva's Torrance works has installed four precipitators for open hearth gas cleaning on its four 58-ton open hearth furnaces at that plant. These reduce the stack dust coming from the furnaces to an hourly average of 2.02 lb compared with discharges of 75 to 245 lb per hr prior to their installation.

A new ferrochromium alloy which was developed during the year should make stainless steel production more economical. This alloy is being produced at a ferro-alloy plant in eight furnaces which were completed during the year. The ferrochrome has practically no carbon (less than 1 part in 10,000). It can be used in the manufacture of low carbon steels and in regular stainless. The small pellets in which the material is produced also give rapid melting.

Nickel was still an item of short supply, resulting in the development and use of several new stainless steels on the basis that manganese can replace nickel in wide ranges. Some possible chromium-manganese alternates were also made. It seems, however, that for the best properties, the alternate steel should have at least 3.5 per cent nickel minimum. These can be substituted for the 18-8 types 301, 302 and 304.

One of the austenitic alternates for 18-8 gives good cold working properties, good weldability and good ductility, and has less than 1 per cent nickel. It has manganese and chromium as the principal alloying elements. This chromium-manganese stainless strip is now being produced in substantial quantities. The steels using less than 1 per cent nickel may not be the answer when extreme corrosion resistance is required.

As was reported last year, the addition of mischmetal may become important in the production of stainless steels. These steels are inherently hot-short. By the addition of about 0.02 per cent of cerium and lanthanum, these highly alloyed austenitic stainless steels may be transformed to ductile alloys. Their addition to the low-alloy austenitic stainless steels which are ordinarily ductile, also give increased ductility or hot workability.

Reports from Russia indicate that transformer sheets may be made with 3.5 to 6.5 per cent aluminum and 2 to 3 per cent manganese. These compare well with silicon transformer alloys as far as magnetic properties are concerned, and it is reported they can be cold worked much better.

The quality of grain-oriented silicon ferrite sheet and strip is constantly being improved. As a result of these improvements, commercial applications are growing fast. In addition, weights of some units such as transformers may be reduced as much as 50 per cent. As a result, the future tonnage of this steel which will be produced will be far greater than what is made today.

With the shortages of aluminum there was an increase in the use of silicon carbide for deoxidation practice. Although this is not new, one steel company set up standard practices for various grades of steel with silicon carbide. On low-carbon rimmed steels under 0.15 C, this is substituted for aluminum on a pound for pound basis.

A new process for making ingots of high grade steels was developed. Steel from the open hearth or electric furnace is treated in a mold heated by induction. The mold is built as a coreless induction furnace and charged with alternating current of network frequency. Water and air are used to cool the mold. Heating current and cooling water are so adjusted that there is no increase in the temperature of the ingot. Since low-frequency heating current is used, the induction effect of the current extends quite far into the steel. The treatment is continued until the impurities such as gases, oxides and slags have had a chance to separate from the steel itself. Much better ingots are claimed as a result of the process.

Continuous casting was finding acceptance, and Atlas Steels, Ltd., of Welland, Ontario, was getting ready to put into operation at the end of the year its continuous steel billet caster. Several similar machines are in experimental use in the United States, but this will be the first commercial production model in North America. In this installation, molten steel is poured from an insulated ladle into a refractory funnel or tundish. If desired, an electric holding furnace can also be used. From the funnel, the molten steel flows into a water cooled copper mold. It is expected that this unit will produce from 150 to 170 tons of billets per 24 hr day.

At another plant in the United States, a company is testing the continuous casting of 10-gage strip.

Another continuous casting machine which has been under experimental operation in the United States is of the same type as that going to Atlas Steel. This plant has found the operation successful and simple. The outstanding principle of the unit is the oscillating mold. The mold travels downward at a rate synchronized with the drawing rolls. After a downward movement of $\frac{3}{4}$ of an inch, the mold snaps back to the initial position through a cam and spring arrangement giving a stripping action, and this cycle is constantly repeated. This plant has found in the four years of experimentation that they can cast numerous steel base alloys in a variety of shapes which are consistently good in quality. A torch is used for cutting off the billets, and a powder torch is used for cutting off stainless steel. This plant has found, contrary to the usual belief, that the machine is easy to start and stop. They always start with a dummy bar which is a close fit with the mold and extends to the pinch rolls. If operation is interrupted, they can run out the casting, replace the dummy bar, and start again in a relatively short time. Thus, one of the disadvantages of the process that a metal supply need not be continuous is overcome. This company is considering equipment which will have 150 sq in. of capacity and which will have about 120 in. per minute casting speed.

Six other continuous casting machines for steel to be located in foreign countries are underway or planned.

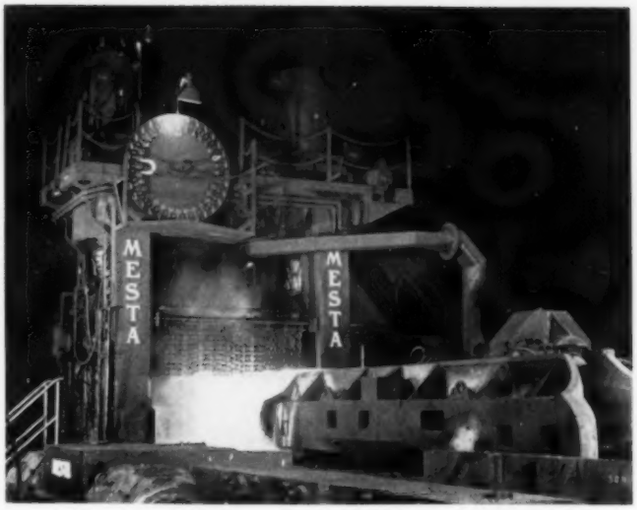
ROLLING

A number of rolling mill units went into operation during the year, replacing uneconomic mills. This was particularly true of blooming mills. A famous old timer was retired during the year, namely the old steam driven blooming mill at Jones and Laughlin's Aliquippa works. It was replaced by a new electric driven mill driven by four 3000-hp motors. Installation took a short time of 7 days, 14½ hours.

A report on the operation of the new 46-in. high lift blooming-slabbing mill at the South Side works of the Jones and Laughlin Steel Corp. was given at an AISE meeting during the year. This mill is driven by a 10,000-hp, twin drive motor, which can reverse the mill from 40 rpm to 40 rpm in only one second. Operators of the mill state that the high rate of acceleration and deceleration helps the operators to handle slabs which develop split ends. Since the operator can see a split end coming out of the mill, he can quickly reverse the rolls and re-enter the slab. As the slab backs out of the mill, the split end then is closed, and since reduction has already been made on the end of the slab, the split does not reopen when it is entered again.

Inland Steel Co. also took out its old 40 x 90-in. blooming mill and replaced it with a 46 x 100-in. two-high, reversing mill. This mill will still be driven by the old double armature 6500-hp drive.

A new two-high, reversing, high lift, 44 x 110-in. slabbing blooming mill was built for Detroit Steel Corp.'s Portsmouth, Ohio division. Scheduled production of this mill is set at 1,300,000 tons per year of slab and blooms. The mill is driven by two 4000-hp, 40/100-rpm motors.



Good performance has been attained on the Jones and Laughlin Pittsburgh works' 46-in., 2-high, reversing, slabbing-blooming mill.

Granite City Steel's new 36 and 54 x 90-in. four-high reversing roughing mill is rated at 1,200,000 ingot tons of steel a year or the full production of the company's open hearth furnaces. The new mill will handle slabs averaging 14,000 lb in weight, and produces steel strip 60 in. wide. Mill is driven by two 3500-hp motors, driving top and bottom work rolls, and a 1000-hp motor operating the edging mill.

During the year the Office of Defense Mobilization established expansion goal for the production of wide flange structural steel shapes at 2,850,000 tons annually by July 1, 1955. This goal provides for an annual increase of 850,000 tons of capacity over the existing 2,000,000 tons produced in 1950.

Shortly thereafter, Bethlehem Steel Corp, announced that its plants will spend $30,000,000 on expansion and modernization of the structural mills at Bethlehem, Pa. This program, it is understood, will result in an increased capacity of 300,000 tons per year.

The first and only mill in the country designed for the production rolling of uranium was put into operation at Fernald, Ohio, during the year.

In the last few years, a number of continuous strip mills have been built and put into production. A recent list shows a total of 58 known or definitely planned mills. Of these, 36 are in the United States and 15 are in Europe. Seven more are located in other countries. Of the mills in the United States, three continuous mills are used primarily for rolling plate. At the present time, practically every West European steelmaking country has gone into flat rolled products in its reconstruction plans. Great Britain alone has three continuous hot strip mills in operation. No other country except the United States has more than two such mills.

Four new large continuous mills for hot rolled sheet and strip went into production in 1953. These included mills at Fairless, Armco, Pittsburgh Steel and Allegheny Ludlum. Armco's mill, a $40,000,000, 80-in. unit at Ashland, Ky., is designed to roll 10-ton ingots into sheet at about 1800 fpm. Capacity is 150,000 tons of finished steel a month. The mill consists of a two-high single-stand slabbing mill driven by a 7000-hp motor. The roughing mill consists of four stands, two of which are two-high, and two of which are four-high. Two-high stands have 40-in. diameter work rolls 80 in. long. Four-high stands have 27-in. diameter work rolls, 80 in. long, with back-up rolls 54 in. in diameter. These mills are driven by one 3000-hp and three 5000-hp motors. The finishing mill consists of six four-high stands having 54-in. back-up rolls and 27-in. diameter work rolls. These mills are driven by one 4000-hp, one 3500-hp, and four 4500-hp motors. Finishing speed is about 1800 fpm. Thickness is continuously checked by an X-ray gauge.

Allegheny Ludlum announced during the year that it had put into operation a miniature cold mill which will roll steel down to 0.00009 in. thick.

At the Allenport works of Pittsburgh Steel Co., a 25-in. and 49-in. x 66-in. semi-continuous hot strip mill went into operation. This mill has an overall capacity of 600,000 tons per year and is the largest installation of its kind to be built in the Pittsburgh district for more than ten years. It is designed to produce hot rolled strip from 20 to 60-in. wide, from 0.060 to 0.188-in. thick, with maximum coil weights of 30,000 lb.

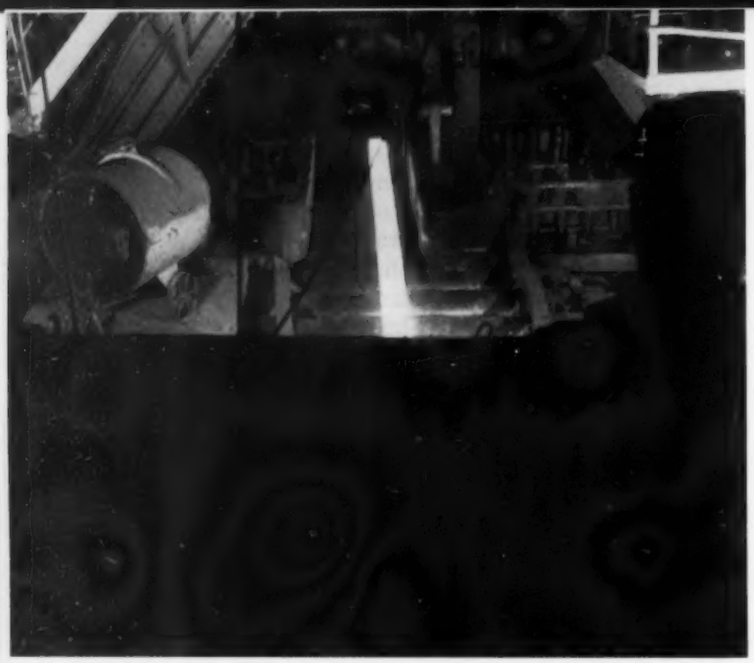
Hot rolled mild steel strip is being produced on the first planetary hot mill of the sendzimir type at Ductile Steels, Inc., Stringes Lane works in Willenhall, England. The mill can also be used on carbon steels with up to 1 per cent carbon, stainless steels, silicon iron and alloy grades. The mill consists of a planetary assembly of 2-in. diameter work rolls equally spaced around a 20-in. back-up roll circumference. The back-up roll is driven by a 900-hp constant speed motor operating at 500 rpm. The small work rolls are free to rotate around the back-up rolls, are synchronized with one another, and rotate at an approximate speed of 230 rpm. The speed of the 2-in. work roll is about 3000 rpm. Immediately following the planetary mill is a stand of 2-high planishing rolls which are driven by a 200-hp motor at speeds running from 14 to 43 rpm. The planishing mill further reduces the thickness, and gives a flat hot rolled finish to the surface. The conventional looper is set between the planetary and planishing mills. Production of mill is rated at 10 tons an hr, but this can be increased. Strip width ranges from 6 to 15-in. and gages from 0.187 to 0.040-in. It is claimed that the thickness of the strip is exceedingly accurate and that a 30-ft slab rolled into a coil does not vary more than 0.002-in. from end to end, and across the width of the strip. Slab lengths can be varied from 15 ft up to the maximum length of 45 ft.

Large reductions can be made with planetary mills, and it is claimed that 40-in. wide x 4-in. thick slab can be reduced in one pass to 0.1-in.

Another planetary mill is under construction for Atlas Steels, Ltd., Ontario.

Production of electrical sheet and strip in 1953 set new records with over 800,000 tons compared with about 607,000 tons in 1952. One of the new and extreme developments in strip is a nickel alloy electrical steel which is being made in widths up to 2 in. and as thin as 0.000125-in.

Reports of tests show that strip gages may be held to very close tolerances by an automatic regulator. This regulator operates by measuring the departure of the roll strip thickness from the desired value and then makes a correction by varying the applied strip ten-



At the Aliquippa works of Jones and Laughlin, the old steam driven blooming mill drive was replaced by a new electric, 12,000-hp unit.

sions. Tests were made on a 20-in. and 44-in. x 56-in. four-high tandem mill installed in 1940. Tests indicate that controls are stable and accurate in operation at speeds of over 1400 fpm.

At U. S. Steel's Pittsburg, Calif. plant, the new 4-stand, 3500-fpm, cold reduction mill has an unusual open sided pinch roll for threading. The top roll operates on a tilting fulcrum. When strip is to be threaded, it is raised and then lowered hydraulically and inched through by a 5-hp motor. Another feature on this mill is that the edge trim baler uses telescopic type shock absorbers to hold down the top roller. Since this bounces from 6 to 8 in. in conventional units resulting in breakage, the shock absorbers here eliminates many of these failures.

Research effort sponsored by the United States Department of Agriculture has resulted in the development of an exceptionally promising substitute for palm oil which is based on white grease, a by-product of the packing industry. Full scale mill trials have not as yet been completed, but preliminary runs indicate excellent performance at surprisingly low consumption rates. These low consumption rates will more than counter-balance the slightly higher production costs of the new oil in comparison with the beef tallow-base material.

Rolling tests performed on a number of mills using a modified beef tallow have shown that this can be used as a lubricant in rolling tin plate gages. Lubricity of various oils have been evaluated by means of wire drawing tests. While the test is not exact, it is useful in gaging the performance of a lubricant for production.

An interesting application of television has been the equipment of the 80-in. hot strip mill at U. S. Steel's Gary works. This unit enables a mill operator to check the condition of the steel strip as it clears the last finishing stand. Cameras are mounted 48 ft above the run-out table leading to the coilers, and command an overall view of the strip from the finishing stand to the coiler. Chief advantage is that it enables the operator to keep a constant watch, spot potential trouble, and pick out such things as cobbles and pile-ups in time to make necessary corrections.

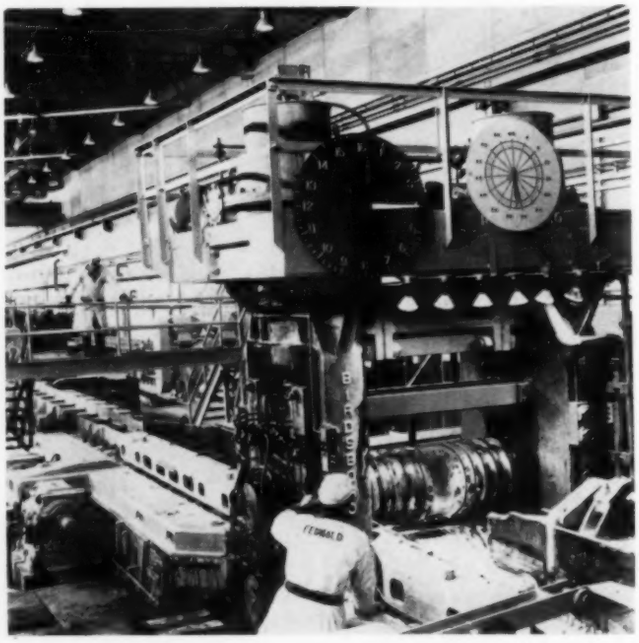
The first high speed, high production, magnesium plate mill went into production during the year at Dow Chemical Co.'s Madison, Ill., plant. This mill is an 84-in. reversing breakdown mill which will produce hot rolled plate 6 ft wide in lengths up to 60 ft, from 2000-lb ingots. Another mill for rolling thin gage sheet will be in operation early in 1954.

Two rod mills, similar to the rod mill which went into operation at the Aliquippa plant of the Jones and Laughlin Steel Corp. in 1952, are under construction or completed. One of these went into operation at Continental Steel Co. Another is about to start up operations in France. These mills roll at constant rate of 50 tons per hr producing No. 5 rod at a top finishing speed of 5000 fpm.

A new steel plant went into operation at Iligan City in the Philippines, which will be operated by National Shipyards and Steel Corp. About 20,000 tons of finished product per year will be made on a merchant bar and rod mill. Steel is furnished from a small electric furnace and another furnace is contemplated. One of the unusual features of the mill is a skew roll cooling bed. This skew gives the rods lateral and longitudinal movement simultaneously, resulting in a continually changing contact point between the roller and the rod as it cools. This gives more uniform cooling, eliminates chill spots and results in a straighter product.

Perhaps no other item of finished product has been as important a factor in the expansion program during this past year as that of tube and pipe. Production of oil country tubular goods alone will show a 35 per cent increase in facilities for 1953 as compared with 1950 to 1951. In 1953, present mill capacity was estimated at about 1,896,000 tons from present mills with 194,000 tons coming from new mills and 125,000 tons coming from conversion for a total of 2,215,000 tons. By 1955, this total will be increased to 2,747,000 tons. These fig-

A primary mill followed by a continuous finishing mill is used to roll uranium into bars. This is the first unit made for rolling of this material.

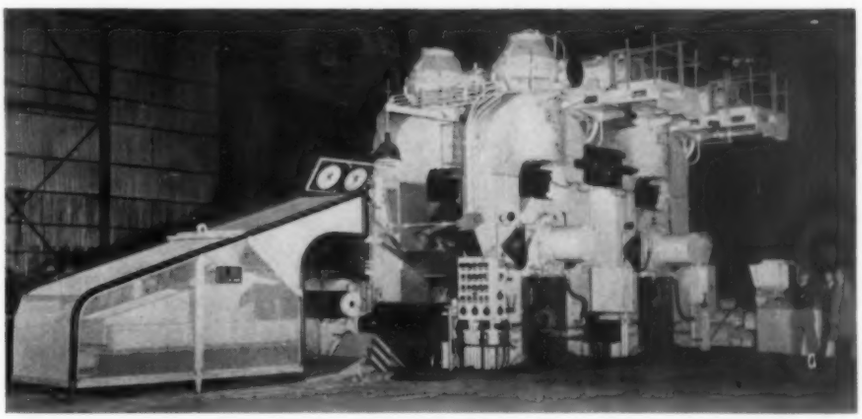


ures are for oil country tubular goods only. Capacity for all pipe and tube reached a total of 13,800,000 tons annually at the end of 1953, or an increase of 65 per cent since the end of World War II compared with an increase of steel ingot capacity of about 31 per cent.

One development in seamless tubing is that seamless light wall tubing is moving into size ranges which once were the exclusive domain of welded grades. One company is now offering outside diameters up to $2\frac{1}{16}$ in., compared with a previous maximum size of $1\frac{1}{4}$ in.

A big addition to seamless capacity took place during the year when Republic Steel Corp. started its new seamless mill at Chicago. This unit has an annual capacity of 180,000 tons per year. Product will be alloy and carbon in sizes ranging from $2\frac{3}{8}$ in. outside diameter to $9\frac{5}{8}$ in. outside daimeter. This is the first seamless unit installed by Republic which has long made welded tubing.

Colorado Fuel and Iron Corp. opened its new $30,000,000 seamless tube mill at Pueblo, Colo. in October. This is the first such unit west of the Mississippi, and will be the important supplier of seamless steel tubing and casing. Annual capacity is 150,000 net tons of seamless pipe a year. Size range runs from $2\frac{3}{8}$ to $9\frac{5}{8}$ in. outside diameter.



Two-stand tandem tin temper mill at Fairless has 19-in. and 53-in. x 48-in. rolls. Maximum design speed is 3740 fpm.

In this mill, 3000-hp motors drive the piercing mills, which are followed by a rolling mill powered by a 1500-hp motor. Heating of the billets is done in a 70-ft rotary furnace, of 75 tons per hr capacity.

Production started in October at the Fairless works of the National Tube Division of U. S. Steel Corp. with the rolling of $1\frac{1}{2}$ in. diameter pipe on the first of two continuous weld mills. The facilities at the Fairless works for making pipe include a skelp mill, two continuous weld mills for producing pipe $\frac{1}{2}$ to 4-in. in diameter, plus galvanizing and finishing departments. This plant has an annual capacity of 281,000 tons of pipe.

Lone Star Steel put two pipe mills into operation during the year, one at the beginning and the other in August. The first mill produces pipe in sizes from $4\frac{1}{2}$ to 16-in. outside diameter, and the second from $1\frac{1}{2}$ to $6\frac{5}{8}$ in. outside diameter.

Globe Steel Tubes Co. installed a 12-stand reducing mill and a reheating furnace during the year. Also under construction is a new 12-stand stretch reducing mill.

It is reported that the Barium Steel Corp. plans to produce seamless tube in sizes which have not been heretofore available in this country. Plans include a new mill for the production of heavy wall seamless tubing to be located at Phoenixville, Pa., at Phoenix Iron & Steel Co. Contracts have been signed between Barium Steel Corp. and Innocenti, S.G. of Milan, Italy, for the production of specialized equipment used in this mill. Similar mills have been built in Germany, Belgium, Sweden and Italy.

A number of steel producers with pipe capacity either purchased or took options on plants which produce plastic pipe. The development of plastic pipe has advanced rapidly in the last two years, and the product replaces steel pipe for some applications. Such plastic tubing has advantages in resistance to corrosion and light weight. The plastic pipe is made in several ways, some centrifugally cast pipe, some extruded. Sizes up to 36 in. in plastic pipe are being considered.

Plastic pipe comes in a number of different types, and which one will work out and be adopted cannot as yet be told. These various types have a wide range of physical properties and also a wide range of costs. A possibility in the use of plastics is the application of a plastic coating to steel pipe. In general, this is more expensive than the tubing itself, and it is difficult to make joints which provide continuous protection. Such pipe would, however, have both strength and corrosion resistance.

Total sales of plastic pipe in 1953 were estimated at $15,000,000 to $20,000,000.

The first steel company to go into the plastic pipe field was Republic Steel Corp., when they purchased Owings-Sharpe, Inc., of Magnolia, Ark. This company produces tubing from $\frac{1}{2}$ to $6\frac{5}{8}$ in. in diameter. Among other producers showing interest are United States Steel's National Tube Division, which has set up a pilot plant in McKeesport to produce plastic pipe for test purposes, and Jones and Laughlin Steel Corp., which has purchased a site adjacent to a plastic supplier, although it has not as yet announced any plans for producing plastic pipe. Youngstown Sheet and Tube Co. also entered the plastic pipe picture by acquiring an interest in Fibercast Corp. of Tulsa, Okla.

Under trial at the present time is a scarfing machine which can be used on stainless steel. The equipment is being tried at a Canadian plant, and the machine is so set up that scarfing is done on all four sides simultaneously. In the operation, powdered iron is introduced which builds up the temperature enough to work on stainless.

The self-centering rolls which were developed a few years ago have met with widespread acceptance. Sev-

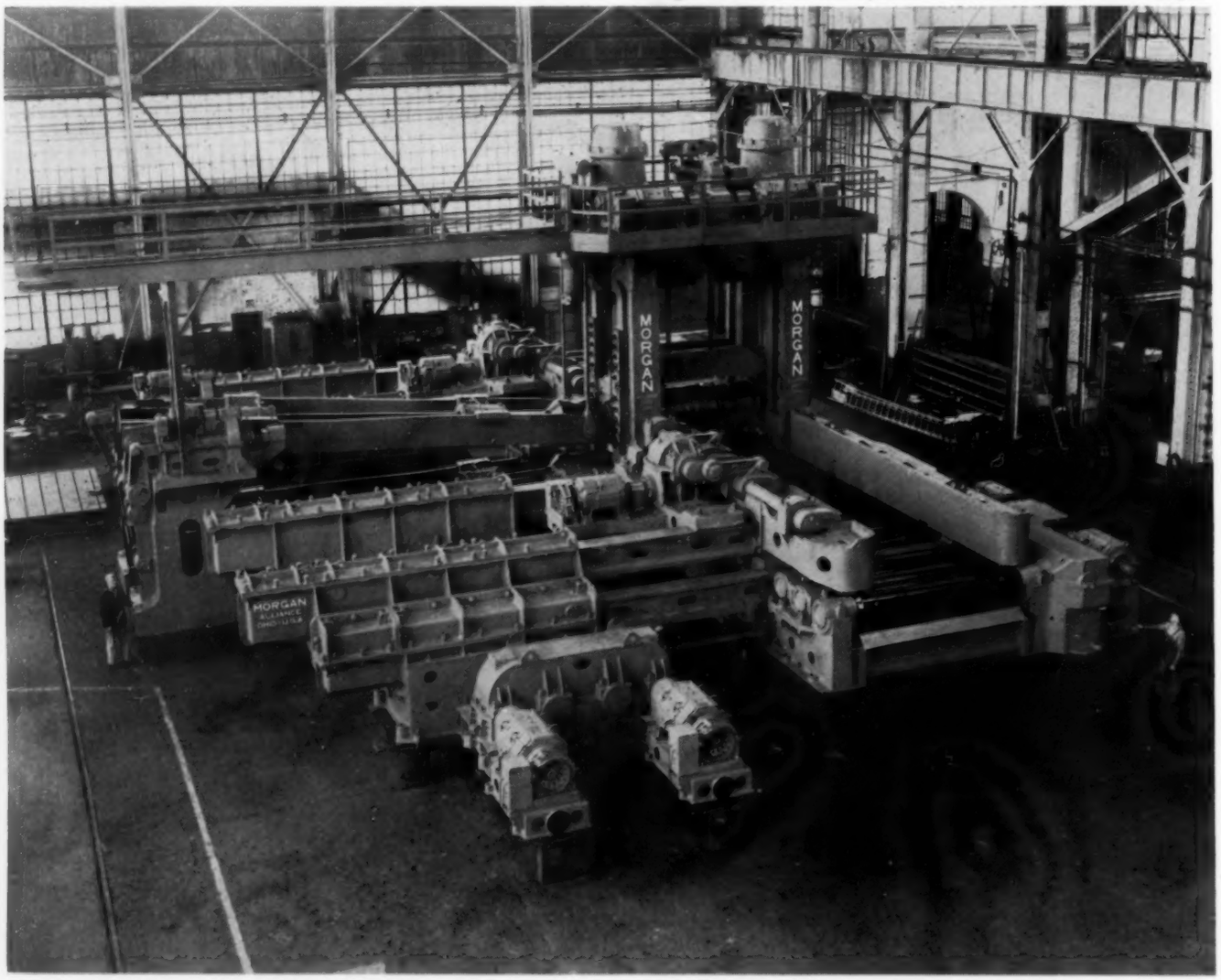
eral variations in design have been developed. They are being used in a number of applications where it is desirable to keep the strip on line. One of the outstanding uses is the continuous tinplate annealing line at the Gary Sheet and Tin Mill. This line, which was originally equipped with full bodied rolls, has been re-equipped with the self-centering rolls. As a result, speeds which before could not be kept above 400 fpm have now jumped to 1000 fpm or better.

A new breaker block has been developed which is designed to limit roll loads. This block was developed by the British Iron and Steel Research Association who have produced a pressure-filled breaking piece which acts consistently to within 2 per cent of the stated load. Breaking load can also be adjusted to suit conditions of the rolls in use.

in order to keep temperatures down. As a supplementary phase to this investigation, measurements are being made on the internal stresses in rolls which are present as they are delivered to the mills. In some cases, these internal stresses are high enough so that when added to the stresses which occur in the mill, from ordinary loading, temperature and improper mill operation, they can easily and quickly cause failure before the roll has given adequate service in the mill.

An unusual 3,000,000-lb stretcher was put into operation this year by the Aluminum Company of America at its Lafayette, Ind. works. It is believed to be the largest in existence and has four times the force of any existing unit.

A 60-in. roll-turning lathe was installed at a Pittsburgh district roll shop, which has all electronic dupli-



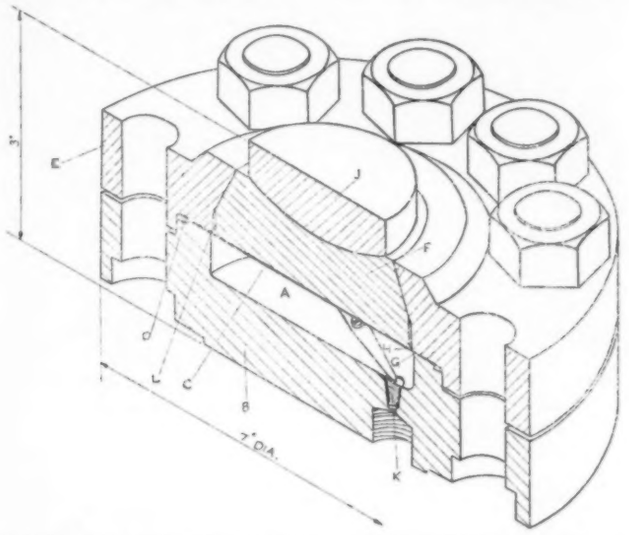
On the shop floor is shown this 44 x 100-in., 2-high, reversing, high lift slabbing-blooming mill built for Detroit Steel Co.'s Portsmouth, Ohio Div.

A progress report was given during the year on a research project at the Carnegie Institute of Technology, sponsored by the AISE in cooperation with the Roll Manufacturers Institute. Work done has resulted in developing the temperature and stress distribution of work rolls in a hot strip mill during the rolling operation. These computations have shown that such stresses are very appreciable and can cause failure. They also point to the importance of proper application of water

cating equipment for controlling the cutting action. This is believed to be one of the first machine tool units of this size to have such equipment. Complex roll shapes can be generated on this roll to produce beams, channels, ship sections, and other rolled steel products.

The heavy press program which was started after the Korean trouble took a marked setback during the year, when the air force announced cancellation of contracts for 17 heavy hydraulic presses slated for production

over the next two years. Both forging and extrusion presses were involved in the cancellations. Among the presses left on the program are two 50,000 and two 35,000-ton forging presses. Extrusion presses left include three 8,000, two 12,000, and one 13,200-ton capacity.



Newly designed breaker block will limit roll loads to pre-set values within narrow limits.

Two 35,000 and two 25,000-ton forging presses were cancelled, and two 20,000 and one 8,000-ton extrusion press were cancelled. However, the nation's largest extrusion press, rated at 14,000 tons, went into operation at the Aluminum Company of America's Lafayette, Ind. plant.

A company in California announced during the year that it had developed an efficient and economical method for the hot extrusion of alloy steel shapes. This company has successfully extruded alloy steel shapes at temperatures up to 2300 F and in lengths up to 30 ft. Details of the process have not been released, but they involved specially developed lubricants and extrusion dies. Some sections produced on the equipment are estimated to cost about $8.90 compared with $29.40 for the same product made by rolling and machining.

FINISHING

The Office of Defense Mobilization revised the expansion goal for electrolytic tinplate to 4,500,000 net tons of annual capacity by January 1, 1955. The previous goal called for 4,100,000 net tons. This target is based on the consumption of tinplate.

The trend in electrolytic tin plate for canned food products is definitely toward thinner coatings. The former standard 0.50-lb base box of the electro-tinning line is being superseded by the 0.25-lb base box plate. There has also been an increasing acceptance of the dual-coated electrolytic tinplate, and this has speeded up the decline of hot-dipped plate as a major factor in the industry. Dual-coat, bearing a 1.00-lb coating on one side and 0.25-lb on the other, is the one winning wide acceptance, and is replacing hot-dipped product in the 1.25-lb grade.

It is estimated that electrolytic tinplate in 1953 comprised about 73 per cent of the total compared with 67 per cent of all tinplate in 1952. The trend toward electrolytic tinplate creates a problem for detinners. Now that the tin coat is getting thinner, it is not as profitable to try to recover it. There are five companies in the detinning business, including one steel company.

Several new developments in electro-tinning have taken place. One of these is a new phenolsulphonic acid plating bath which deposits tin almost as bright as can be obtained by the present methods of melting after the tin has been coated. These deposits are free from toxic occlusions. Such bright deposited plate is of advantage over the melted coating since there is no alloy layer. Improvements to the halogen bath have been made, and it has been found that the addition of thiourea to the standard halogen bath will reduce oxidization and sludge formation.

During the year a new commercial process for the electrotinning of wire was developed.

One of the fastest operating electrolytic tinplate lines in the United States went into production at U. S. Steel's Pittsburg, Calif. plant. This unit is operating at speeds of 900 fpm on 0.25 lb electrolytic tinplate.

A new type of gage for measuring the tin thickness on tinplate is being made for a Pittsburgh producer. This new gage uses X-rays and is supposedly accurate to one-millionth of an inch. Delivery of the gage is expected early in 1954.

Pittsburgh Steel's new 4-high reversing rougher is driven by two 3000-hp motors.

Although there is a trend toward increased production of sheet and strip, this has not been the case with galvanized sheets. Galvanized sheet output increased about 42 per cent from 1940 to 1952, compared with 62 per cent for total sheet and strip use.

There are now 14 continuous galvanizing units in operation in the United States. Most of these start with a fully hard coil which still has roll oil on it. This is cleaned either by gas, pickling, alkali cleaning or by oxidizing the surface in an open flame furnace. The steel is then normalized in a controlled atmosphere and cooled to around 950 F, after which it goes into the zinc bath. Strip is then cooled in a cooling tower. Several other units are under construction. When these are completed, the industry will have an annual capacity of over 1,000,000 tons per year in continuous galvanized sheets.

Wheeling Steel Corp. put into production a new con-

tinuous galvanizing line at its Martins Ferry factory. This line, which was built at a cost of $3,000,000, is about 600 ft long and will coat coils in gages from 18 to 32 and in widths up to 36 in. It is estimated that its speed will exceed that of any continuous zinc coating line in operation.

A number of coatings other than tinplate are being investigated. Extensive research in particular is now being conducted to develop an organic coating for sheet steel. A number of resin linings are being tried for various uses.

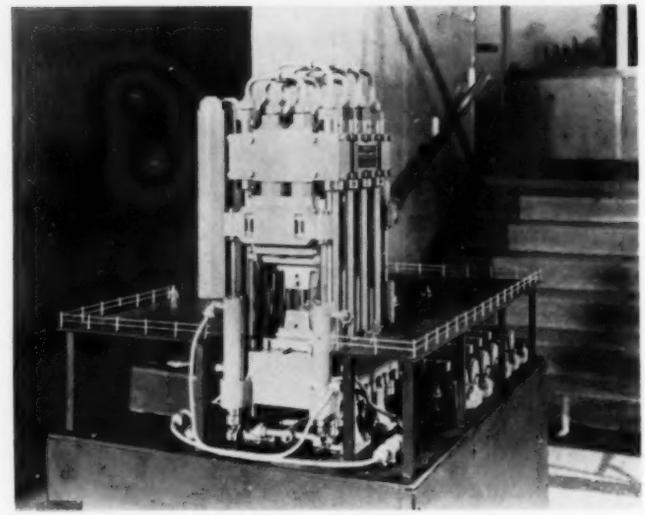
Another process has been developed in which silicone resin based enamel is applied to steel. This is much harder than standard coatings and yet flexible enough to permit forming after finishing, which should make the material a competitor of porcelain and galvanizing in some applications.

Consideration is also being given to the possibilities of producing a wax coated steel sheet in the mill for drawing or stamping applications. Waxes which are applied immediately after rolling are not expected to deteriorate with storage. The wax would protect the raw sheet from corrosion and damage, and also serve as a drawing compound.

Production is increasing in clad products. Superior Steel Corp. dedicated a new clad metal plant during the year which increased the company's capacity from 30,000 to about 80,000 tons per year.

More and more aluminum is being used as a coating on steel. Either pure aluminum or iron aluminum compounds may be used. Methods used include calorizing or some similar treatment involving diffusion, plating from a vapor phase of aluminum chloride, metal spraying, electroplating, and hot dipping. One hot dip aluminum process uses pickled, cleaned and dried steel wire, or strip, which is passed through a hydrogen atmosphere furnace at 1650 to 1830 F and then into an aluminum bath maintained at 1300 to 1400 F. Another process involves oxidation of the steel, and subsequent reduction of the oxide film by using a suitably controlled furnace atmosphere before the metal enters the aluminum bath. Other hot dip processes use a molten flux.

The year saw a number of improvements in handling of coils.



The air force heavy press program was cut back extensively in 1953. View shows model of one of the 35,000-ton forging presses.

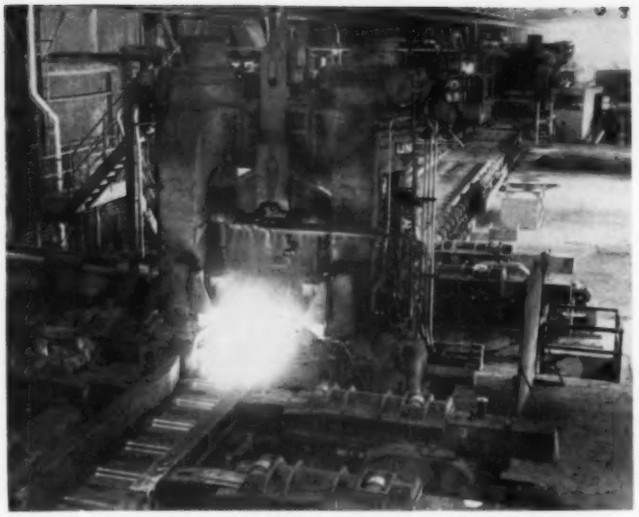
A plant went into production during the year which will nickel plate pipe for the Atomic Energy Commission. Pipe will run from 2 to 54 in. in diameter. In the process, a long nickel anode is inserted and held in the center of the pipe. Pipe is then flooded with a plating solution. A selenium rectifier is used to supply the d-c power at rates up to 30,000 amperes.

A new chemical process causes deposition of a hard nickel plating on either metallic or non-metallic surfaces. Process can be used on items of their regular shapes and large sizes. The advantage is low cost uniform coating, regardless of roughness, with little or no porosity. Part is immersed into an agitated solution of nickel chloride and sodium hypophosphite held at 212 F. This method can deposit predictable thicknesses of plating.

Alan Wood Steel Co. placed a new continuous strip pickling unit in operation at its Ivy Rock, Pa. plant. Building and equipment involved an expenditure of $2,500,000. The unit is able to process about 20,000 tons of strip per month.

Advantages inherent in mechanical descaling are leading to increased use of this method, since it eliminates pickling and oiling as well as possibilities of hydrogen embrittlement. Another advantage is that either intermittent or continuous operation is possible. Tests have shown that sheets as thin as 16 or 18 gage can be cleaned for as little as $2.80 per ton total cost as compared with pickling costs of about $4 a ton. Strip can be cleaned mechanically for $1 to $2 a ton as against a cost of $2 to $3 a ton for pickling.

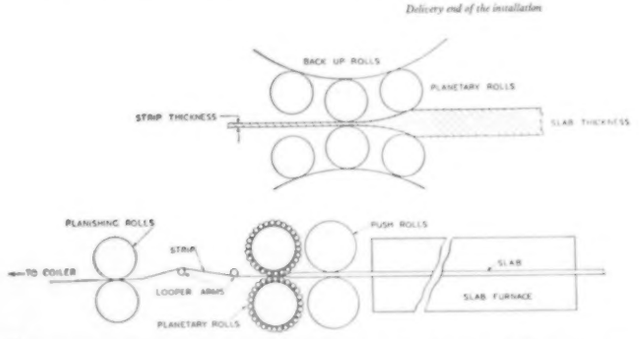
One such shot blast cleaning unit enables a cold mill to take 36¾-in. coils of type 430 straight chrome stainless steel from the hot mill to the cold mill without scalebreaking. Better quality and a more uniform prod-



Installation of the 4-high reversing roughing mill at Granite City Steel Co.'s plant increased markedly this company's capacity for sheet and strip.

uct is accomplished while saving time. Strip goes through at about 7½ fpm, which speed is set by the annealing cycle.

The development of an advanced practical method of metal cleaning through the use of ultrasonic waves was announced during the year. Construction of a new transducer element has taken this method of cleaning out of the laboratory stage and made it a production reality. One unit built has a frequency of 430,000 cycles per second. Solvent used is trichlorethylene. Unit is particularly valuable where exceptional cleaning quality is required, and where parts have fine openings or crevices, or have other hard-to-clean shapes.



Extremely large reductions are a feature of the planetary mill.

A new waste pickle liquor recovery process invented by a Viennese engineer has been improved and adapted to American engineering standards. The process recovers the entire sulphate equivalent of the waste pickle liquor as a reusable sulphuric acid, without the installation of an expensive contact or chamber sulphuric acid plant. The iron is recovered as pure iron oxide which is recharged to the furnaces. In the process, the pickle liquor is concentrated by evaporation. The ferrous sulphate is then converted to ferrous chloride by adsorption of the hydrogen chloride. The precipitated ferrous chloride is removed from the mother liquor by centrifugation. The regenerated sulphuric acid is returned to the pickling line without further processing. The ferrous chloride is roasted to produce hydrogen chloride for recycling to the process, and iron oxide is produced as a by-product. It is estimated that complete facilities to process spent pickle liquor for a steel plant using 10,000 tons of sulphuric acid per year would cost about $500,000.

A new tool which has been proposed for recovery of pickle liquor is the recently developed membranes of selective permeability. These work on the ion exchange principle and are able to handle spent pickle liquor on a continuous process. Laboratory tests have demonstrated that the total sulphate equivalent may be directly reconverted to acid of sufficient purity and strength to recycle through the pickle lines. The iron is thrown down either as a high grade oxide or a metallic iron sludge. Earlier types of this equipment have had low capacities per unit of area.

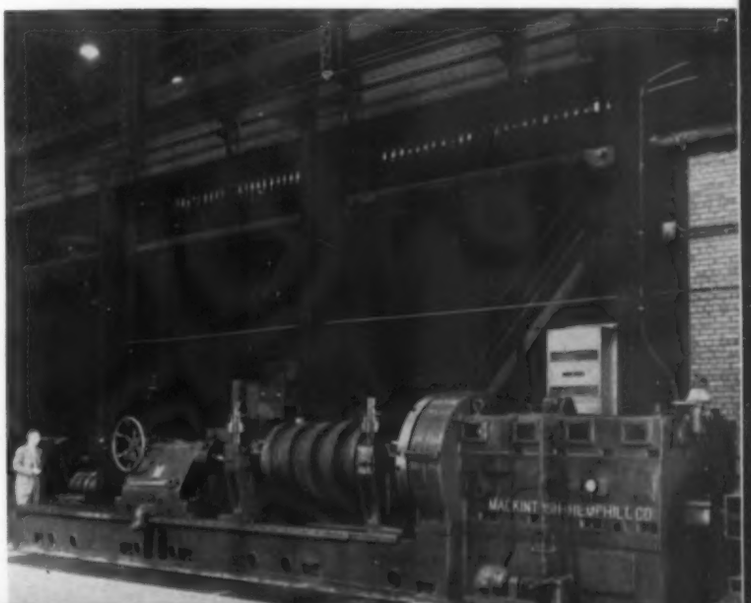
FURNACES AND CONTROLS

A development which may revolutionize many heating practices, provided the economics prove favorable, is the use of low frequency induction heating for both ferrous and non-ferrous applications. The practice is growing because of the large advantage in low initial equipment cost as well as the higher heating rates which can be obtained. One of the advantages of such units is that the three-phase heater will draw a balanced load from the electrical circuit.

Units have been built which will handle aluminum and magnesium billets up to 32-in. in diameter and over 80-in. long. These billets are to be used in one of the large extrusion presses being manufactured under the United States Air Force heavy press program. Most of the heaters which are built are of the vertical coil construction which takes the weight of the billet off the coil. A 6000-lb aluminum billet as indicated above can be heated to extrusion temperatures in 35 minutes compared with the heating time of about 14 hr with the conventional heaters.

One of the applications of 60-cycle induction heating is a billet heater for steel extrusion presses. This heater will preheat both carbon and stainless steel billets 5 in. in diameter or larger to 2300 F without the use of high frequency generating equipment. The unit can also be used for titanium and other alloys.

Lathe shown is a 60-in. electronically-operated contour unit.



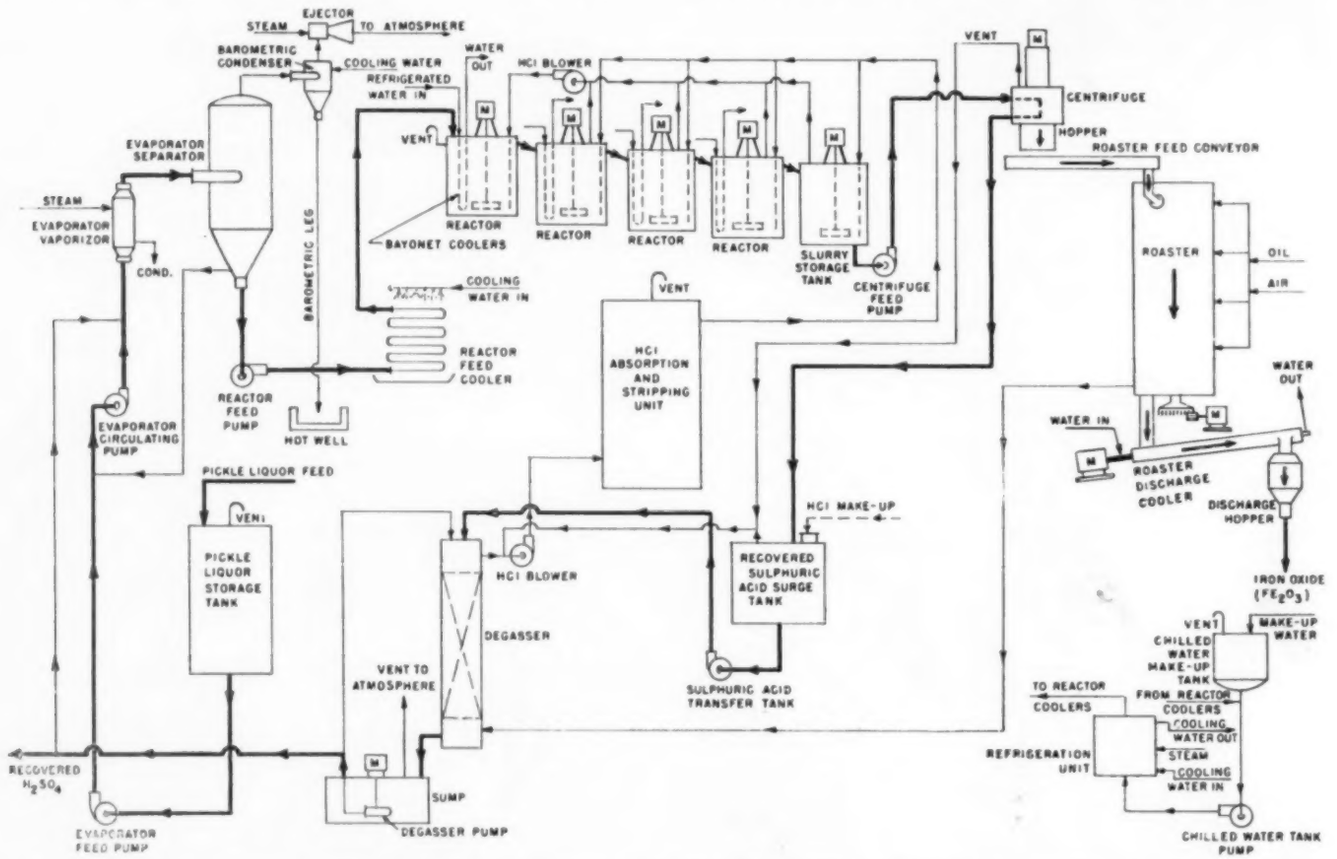
A series of test runs have been made on induction heated specimens for billets which are to be extruded. These tests have shown that adding an inert gas in heating coils to displace oxygen has provided much better extrusion quality. These billets were processed on the 2500-ton steel extrusion press at Babcock and Wilcox at Beaver Falls. Several production units of billet heaters are to be installed in January 1954. These units normally will consist of three or more heaters grouped into a single assembly. It is estimated that these units will preheat steel billets 6-in. in diameter from room temperatures to 2300 F in five minutes.

Also under construction are heaters for carbon steel which will use two stage heating with both single and dual frequency. The reason for this is that the electrical heating characteristics of carbon steel change materially at the Curie Point (1300 F) and it may be desirable from an engineering and economic standpoint to use one set of coils when heating up to this point and another set when heating beyond this point. The frequency to use in the final heating coil will depend upon the billet size, and the larger the diameter of the piece to be heated, the lower is the required frequency.

Demonstration on low frequency induction heating was made in November at a clinic to which a number of steel plant operators in western Pennsylvania were invited. In this demonstration steel billets 8 x 8 x 30-in. were heated to a uniform 2200 F temperature throughout after 20 minutes inside the 60-cycle induction heating coil. At the demonstration, also, a 13 x 13 x 30-in. billet was heated in less than one hour to rolling temperatures with an efficiency of 80 to 85 per cent based on the ratio of heat in the kwhr input to the increased heat in the billet. Although it takes a very short time to reach temperature, it does take some additional time to soak the billets so that the temperature is uniform throughout. The right procedure may be to apply the heat for a period of time and then cut back in order to let the temperature soak, and then apply an additional amount.

Lukens Steel Co. announced that construction is under way on one of the largest continuous heat treating furnaces in the world. This unit, another step in their $22,000,000 expansion program, is being built to heat treat armor plate, alloy steel, and carbon steel plates. The annealing line has an overall length of 365 ft consisting of a 50-ft charge table, a 202-ft roller hearth furnace with 10 zones of 20 ft each, a 10-ft transfer table, a 1000-ton quench press 43 ft long, and a 50-ft discharge table. Plates up to 130 in. wide x 480 in. long, and from $\frac{3}{16}$ to 2-in. thick, having a temperature range from 950 to 1950 F can be handled by the equipment. Heat-treating cycles will vary from 10 minutes to 12 hours. Capacity for stainless is 13,250 tons per month.

A new type of slab heating furnace which can heat up to 70 tons per hr of stainless steel, silicon steel, or carbon steel from room temperature to 2275 F was put into operation in December by Allegheny Ludlum Steel Corp. at its Brackenridge, Pa. plant. The unit heats slabs from 5 to 9 in. thick in lengths up to 17 ft 3 in. This pusher type furnace differs from conventional slab heaters in that heat is applied through burner

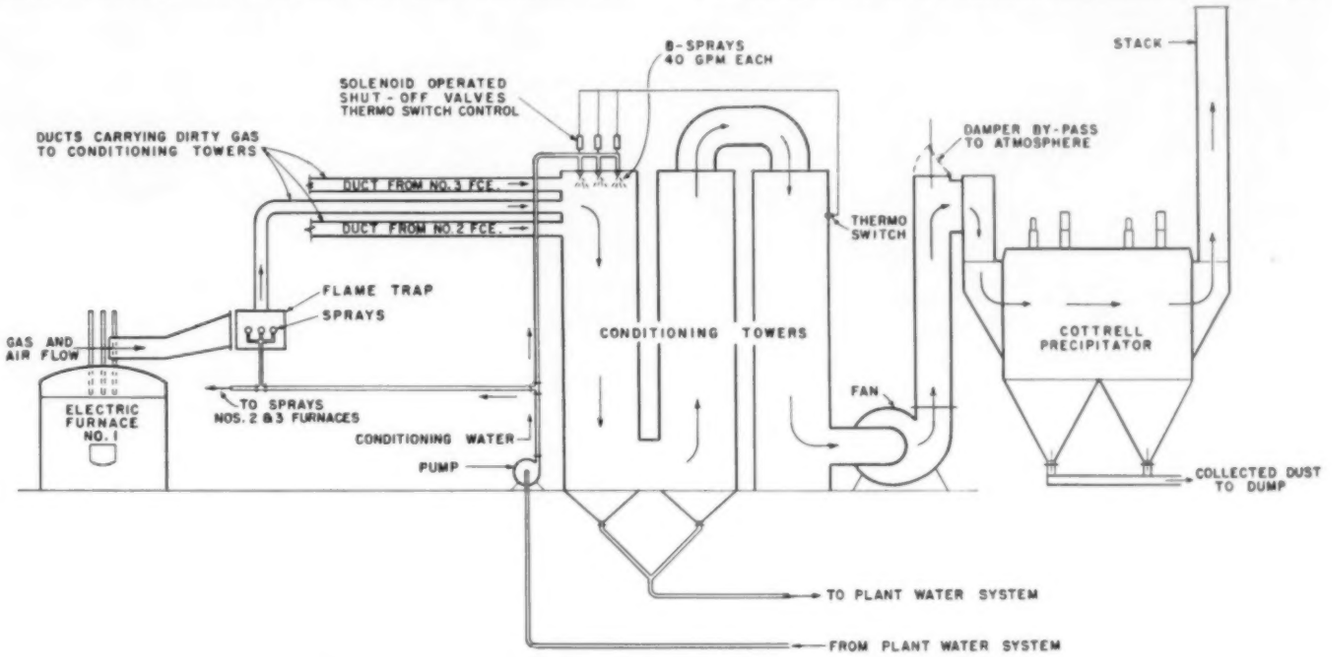


Solution to the recovery of waste pickle liquor problem has been incorporated in the design here shown. It was originally developed in Vienna.

ports located along the sides and at the discharge end of the furnace rather than just at the discharge end. This gives faster and more uniform heating. The furnace is 107 ft long and can be fired with either gas or oil.

Better heat convection in batch type annealing furnace was accomplished at a large eastern mill which handles mostly coils of ⅜ in. austenitic stainless steel

The use of plastic, castable and gunning materials in soaking pits and other refractory applications in the steel plant is meeting with increased favor. Such materials have been used in soaking pit slab type covers, on coping, and also on soaking pit walls. One plant put plastic material into the division wall from the slag line up and also used a castable material on the outside



Units have been installed to clean the exhaust gases from arc furnaces.

rod. By the use of a new high velocity burner design, circulation was stepped up in the furnace without mechanical means. In the burner, recycling of the products of combustion to the throat of the venturi is accomplished by means of the low pressure zone created at that point by the primary air. Fuel is injected through a pressure atomizing nozzle at this point so that hot products of combustion are immediately brought into contact with the atomized oil where vaporization takes place. No secondary air is needed.

An east coast brass mill recently put in one of the world's largest non-ferrous direct gas-fired annealing furnaces for annealing slabs and sheet coils. This unit can anneal 33,000 lb of brass per hr at temperatures as high as 1382 F.

A means of cooling strip which requires less space than the conventional is a wind tunnel which has been installed in several plants. The turbulent air stream cools the strip as much in ten feet as has previously been done by exposing the strip to room temperatures for distances of many hundreds of feet. Several of these tunnels up to 46 in. wide are now in operation. Forced air, furnished by supply fan, plus a venturi effect, speeds air movement to 200 mphr.

New automatic controls have reduced the fuel required for ingot heating in soaking pits by appreciable amounts. Newer instruments, with more accurate sensing and response, should make further gains on this in the next few years. Another development provides a means for summarizing the air requirements for combined fuels which results in better distribution of fuel throughout the plant.

pit wall to establish a basis of comparison between the two materials. This plant has since gradually increased the use of the castable material, and at the present time has in service a number of walls, arches and bottoms of such castable material. The castable or plastic material is applied through a cement gun in performing repairs and maintenance. This plant feels that as a result of these applications, it has increased heating efficiency of the pits, increased blooming mill production and realized economies in soaking pit operations.

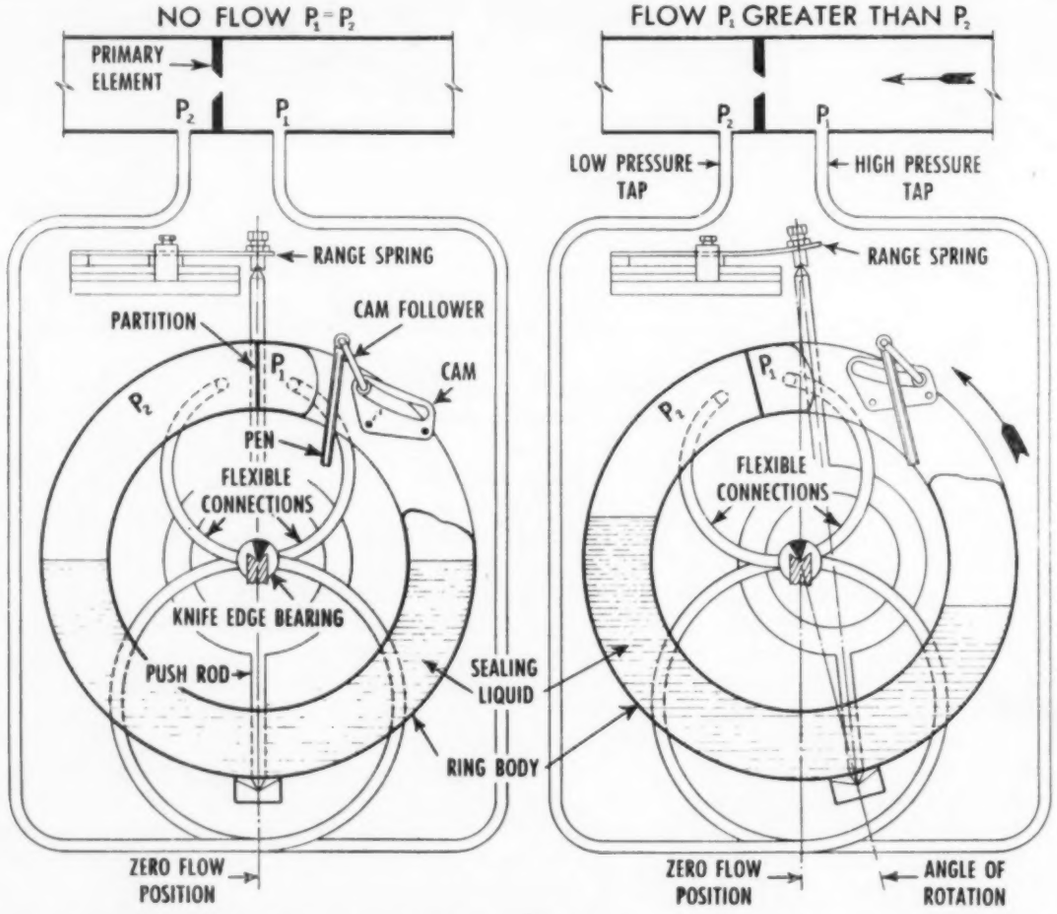
An insulating material that can be sprayed on metal

The new hot strip mills necessitated installation of a number of soaking pit units. Pits shown are located at Armco Steel Corp.'s Ashland, Ky. plant.

surfaces like paint and offers protection from heat up to 5,000 F was announced during the year. The coating, when $\frac{1}{16}$ in. thick, can protect surfaces up to 10 seconds against flame temperatures which are hotter than the melting point of the metals. It is a water-base inorganic material. No treatment of the metal is required for its use.

The ever increasing use of oxygen in steel plants has created considerable interest in wide range metering systems. One piece of equipment which has been successful in accomplishing this purpose has been the ring balance meter. This equipment has the ability to measure flow rates which vary widely at good accuracy. Meter can provide results automatically corrected for pressure and temperature variations.

A precision flow detecting instrument, designed to sense and respond to changes or stoppages in the flow of air, can be used as a warning device in air-cooled equipment for ventilation control or for any application where a particular flow rate must be maintained. It can also, of course, be used as a liquid-level detector or controller in storage and supply tanks. The unit has no moving parts but operates on the principle that the amount of heat conducted away from a constant heat source varies with the flow of air moving past the surface. A small internal heater heats one leg of the unit. As the flow rate drops, the heated leg expands because less heat is conducted away. The result is that expansion is transmitted through lever action to a strut-and-electrical-contact assembly in the other leg.



Ring balance meter is being extensively applied to wide range metering of oxygen.

A thermocouple developed during the year is especially useful in measuring transient temperatures. This unit has a junction thickness of only one micron, but is of such rugged construction that it can be used to measure extremely rapid temperature changes in regions of high stress. The unit was developed as a means of measuring gun bore surface temperatures. An unusual feature of this unit is the probe which contains the junction. The probe consists of a thick-walled steel tube plated on one end with a thin one micron thick layer of nickel. The interface between the nickel plating and the underlying end of the steel tubing is the plane at which the thermal emf is generated. The lead wire to the plating is mounted in the center of the tubing. This wire is also of nickel and is coated with a nickel oxide which serves as electrical insulation between the nickel wire and the steel tubing.

A study completed by the National Petroleum Council indicates that the Bureau of Mines' proposals for the manufacture of synthetic gasoline from coal and oil shale are definitely uneconomical under present conditions. They also feel that the need for a synthetic liquid fuel industry is still in the distant future. The committee has concluded that gasoline manufactured from oil shale would cost the wholesale purchaser 14.7 cents a gallon at the refining point. Gasoline made from coal by the Bureau of Mines Fischer-Tropsch process would cost 29.4 cents a gallon. They estimate also that gasoline made from proposed hydrogenation processes would cost at least 36.3 cents a gallon. These figures compare with gasoline refined from crude petroleum at about 12 cents a gallon at the refinery at the present time.

MATERIALS HANDLING

The Office of Defense Mobilization announced one revised expansion goal for material handling equipment during the year. This was established at $30,000,000 of capital investment to be completed by January 1, 1954. This expansion was to be divided into $14,000,000 for industrial trucks and tractors, $9,000,000 for powered conveyor equipment, $6,000,000 for overhead travelling cranes, and $1,000,000 for other types of cranes, hoists and monorail systems.

A new safety hook block was demonstrated during the year which should reduce crane accidents which may occur if the hook block is run up through the limit stop. This device incorporates a spring mechanism with sufficient capacity to absorb all the kinetic energy in the hook block and in the rotating parts of the crane. When such a unit is used on a crane, it eliminates any possibility of dropping the hook block, either through negligence or failure of the electrical mechanisms, since the spring mechanism will bring the block to a safe stop, at the same time reducing to safe limits the dynamic stresses.

A stabilized crane which eliminates the usual load swing while hoisting was shown during the year. The crane has a simple arrangement of hoisting ropes which form a triangular suspension. This permits the load to be held in place so as to eliminate longitudinal, lateral and rotational sway.

Another development for prevention of swinging of the crane hook involves the use of servomechanism feed back techniques. These have been applied to the trolley drive to stop swing and they have also been applied to the hoist drive to obtain continuously varying speed hoisting with an automatic smooth stopping feature. These two are separate control systems, independent in their actions.

New type of towboat propulsion uses variable pitch vertical axis propellers. Boat is very maneuverable and requires no rudder.

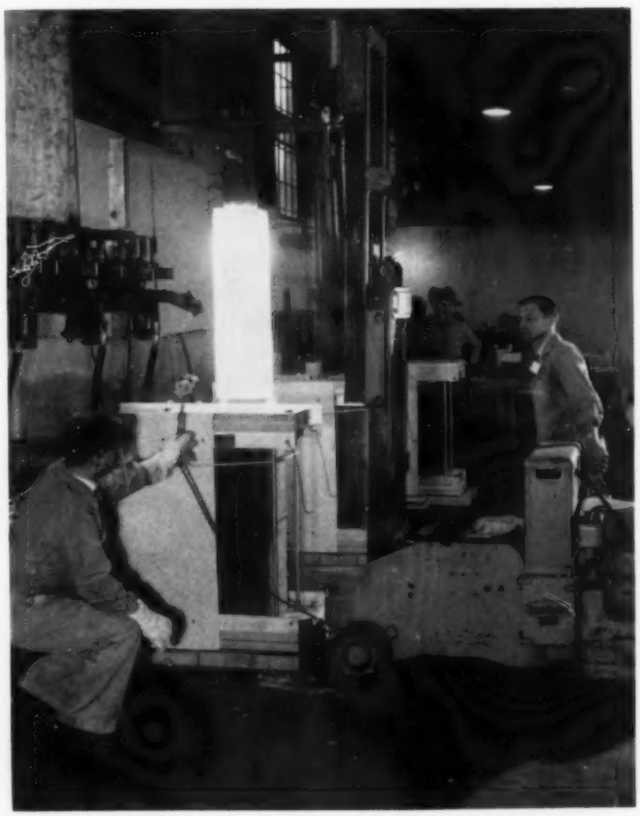
A new flexible runway connection has been developed which should cut down maintenance problems arising due to misalignment of runways and settlement of building columns in mills. The new design holds the girder at the proper distance from the column and takes the cross thrust at the top flange, thereby protecting the web; it does this without regard to the kind of diaphragm.

The first gas-powered industrial truck with an electric transmission was introduced during the year. This unit is entirely new to the materials handling field and features radical changes in design and appearance. It offers the low maintenance cost and performance characteristics of straight electric trucks, plus the constant power source that can be derived from a gasoline engine. The electric, infinite-step transmission has no mechanical connections from engine to drive unit, thus eliminating transmission gears, hydraulic torque converters and overdrive mechanisms.

An interesting development in a lift truck is one on a 50,000-lb capacity unit built for an English steel plant. This truck features a special power-driven, rotating, load-carrying ram which can be used to tighten loose coils of rolled steel.

Up to December 1, the Great Lakes fleet established a new record in the combined tonnage of iron ore, coal and grain carried. Tonnage totaled 164,480,105 net tons as of that date. This is 6.4 per cent over the previous record of 154,955,588 tons set in 1942, and 25 per cent over 1952, when the strike cut down movement. Of this amount, 95,844,499 gross tons or 107,345,783 net tons were iron ore. This record iron ore shipment from the upper lake to lower lake ports may stand for some time because of the influx of ore in 1954 from sources other than Lake Superior, which will be much greater than heretofore. Also, the shipment of ore concentrates will increase, and it will take less tonnage of 64 per cent iron ore to give the same iron content as the present 50 per cent iron ore. A third factor is that demand in 1954 will probably not be as high as it was in 1953.

The 60-cycle induction heating unit will undoubtedly find a place in many steel plant operations.

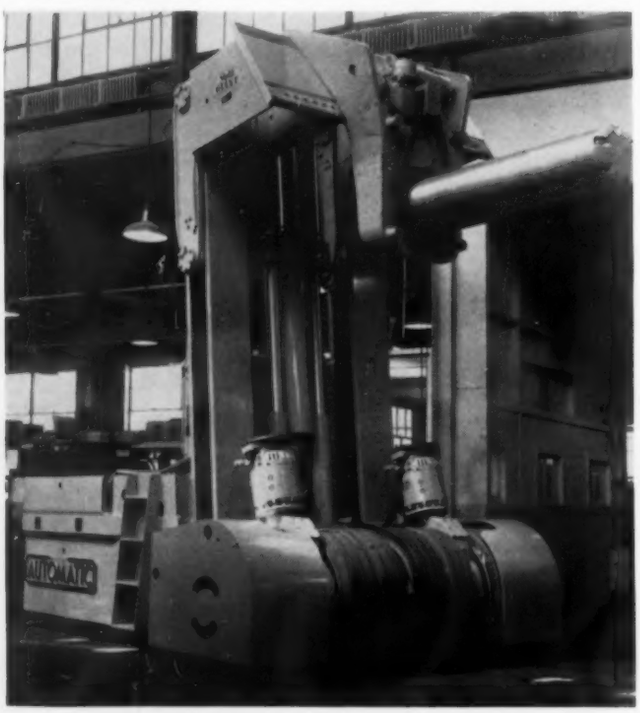


The 90-mile railroad of the Orinoco Mining Co. in Venezuela has been built with a number of interesting features. Unique in the setup of this railroad is microwave radio channel communication similar to that used in television, which can be used for operating remote control switches, signals and interlocks on the railroad. The single track railroad has four long sidings, two of which are governed by the radio waves transmitted from the Puerto Ordaz tower. Another unusual feature of this railroad is an automatic setoff. The railroad runs downgrade with the loaded trains from the mine down to the terminal. Electronically controlled speed measuring devices are located along the railroad which will determine whether the train is moving at excessive speeds. If so, they can radio automatically ahead to the next setoff switch, and the train will be run through the switch into a siding where an upgrade will bring the train to a gradual stop.

An interesting development in the operation of ore trains is the use of a computor card system for weighing ore cars as they come out of the fields at Burnt Creek, Canada. The cars are run over track scales, weighed, graded and automatically recorded. When the trains reach Seven Islands the next day, they will be automatically broken up according to information that has been flashed ahead by the computing card system, and the ore will be dumped into special bins according to grade. This development is also being adapted for use in the coal fields.

A new method of propelling river towboats was demonstrated during the year on the Ohio River with a 2000-hp boat equipped with sinusoidal propulsion. The boat is unusually maneuverable because it can deliver thrust with equal effectiveness in any direction. Thus, there is no need for rudders such as are used on conventional screw-type propeller boats. The propulsion is supplied by sinusoidal, vertical axis propellers. The business end of each propeller consists of an arrangement of vertical blades with controllable pitch, projecting downward from a rotating disc at the base of the unit.

This specially designed lift truck has a revolving ram for rotating coils.



New docks built for Weirton Steel provide additional capacity for handling barges. Primary purpose is to load finished steel.

MECHANICAL

There has been a great deal of interest and study on the feasibility of developing usable power from nuclear plants. The first test plant was a 100-kw unit which started on December 21, 1951, at Arco, Idaho. On February 24, 1953, 150-kw was developed in the government's homogeneous reactor experiment. As a result of these small units, various groups from public utilities, in conjunction with government groups, have been making studies to determine the commercial practicability of developing large scale commercial power units. So far, plans for only one actual plant are under way. Some of the items holding this back are questions on financing and methods of handling some of the by-product radioactive materials.

As seen now, the typical reactive plant would use fuel elements made of natural uranium. Heavy water would be used as a moderator, reflector and coolant. Boron steel control rod assemblies would be installed and actuated by servo-mechanisms to regulate heat output. Around the reactor would be a thermal shield, and around that again, a biological shield as a safety precaution to those who may work around the reactor. Heat exchangers would then remove the heat, forming steam which would run turbogenerators.

One of the questions holding back development is whether plants should be dual-purpose plants in which plutonium suitable for weapons would also be produced or whether they should be power plants alone. However, unless the government can guarantee to purchase the plutonium and other radioactive products, industry may not be able to afford to build a dual plant on this basis.

Four groups were authorized by the Atomic Energy Commision to make the necessary studies for the design, construction and operation of nuclear reactors for the production of both plutonium and power. Over one

hundred engineers and scientists of the firms involved have been working on the project, and it is estimated that the activities involved will cost the firms about $1,000,000. Pertinent parts and condensed versions of reports were published during the year. Each of the four groups apparently decided that a different reactor type held the most promise. In the studies of the different reactors, different coolant mediums are involved, and what will eventually be used cannot be told at the present time. A number of the proposals contemplate the use of liquid sodium, others water.

There are a number of atomic reactors now in operation. The exact number is not known, but apparently there are 13 in operation in the United States with another one under construction. A few others are scattered throughout Canada, England, France, and Norway; a number of other countries have them under construction. These previous units are experimental. There are two experimental power reactors in this country, one at Arco, Idaho, and one at Oak Ridge, Tenn. There is also one in England. In addition, at Arco, Idaho, the AEC has one for ship propulsion.

In October, the Westinghouse Electric Corp. was selected to build the first full scale atomic power plant in the United States. This is to be a 60,000-kw reactor and apparently will produce electricity alone and will not be a dual purpose unit. It is not definite what the reactor will use for the cooling agent and for heat transfer. An interesting feature of the plant to be built by Westinghouse is that the 60,000-kw unit will probably use only about 15 lb of fuel a month.

The power industry is not depending upon atomic developments alone. A major forward step in steam units is a new boiler and turbo-generating unit which crosses the barrier of super-critical steam pressure for the first time in the commercial production of electric power. This unit will use steam pressures of 4500 psi and temperatures of 1150 F and have a capacity of 120,000-kw. The boiler pressure is about double the present highest steam pressure used in power generation, and the temperature is about 50 degrees above the present maximum. The unit will have two stages of reheat, the first at 1050 F, and the second at 1000 F.

A number of power plants installed fly ash collector systems during the year. Many of these were electrostatic units. In these installations, there has been a trend to increase collector efficiency by picking up more ash as well as larger percentages in the smaller particle sizes.

The use of electronic devices to weigh materials in steel plants is meeting with increased acceptance. Such units usually combine the resistance wire gage with electronic instrumentation. The instrumentation can be so set up as to give the weight on a direct reading scale or by means of printed cards. The weighing equipment can also be used as crane scales, being incorporated in units tied in with the hooks. Similar units are also used to measure the load in mill housings.

A variation of magnetic clutch was put into operation on a number of units during the year. This variation uses magnetic stainless steel particles instead of iron powder. The collectors using iron powder had developed erratic behavior in disengaging. This is attributed to corrosion of the iron fostered by sulphur in the oil. Through the use of a non-corrosive medium (stainless) the troubles were eliminated.

Ultrasonic testing has been improved through the use of liquid coupling. Previous methods most widely used are the contact method, which is not too good for rough surfaces, and an arrangement in which the pick-up unit is immersed into a liquid. The special coupling device which has been developed provides a compromise between the two methods and combines most of the advantages.

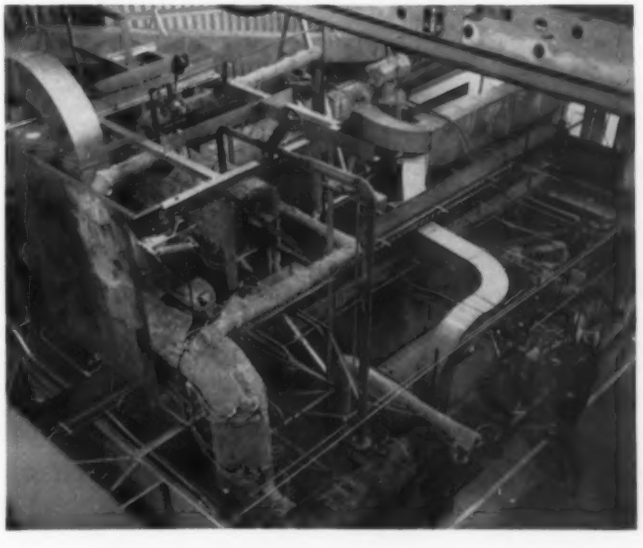
A nearly fool-proof method of finding leaks uses freon-12, a fluorinated hydrocarbon which under pressure is a colorless, practically non-toxic and odorless liquid. This changes to a gas when released from pressure at room temperatures. Its value as a leak detector comes from its ability to escape through the finest opening in almost any materials. The exact location of the leak is then found quickly by an electronic device, or by a gas-burning torch whose flame changes color when contacting the chemical.

A newly developed industrial adhesive is so sensitive that it takes only fingertip pressure to join the materials together, and will permanently fasten rubber, metal, plastics, ceramics or fibres together, or in any combination. After being put together, strength of the material is as high as 10,000 psi. The new adhesive is extremely stable and resists attack by salts, alkalies, acids, moisture or solvents.

Plastics have been used successfully in the applications of corrosion-resistant pumps and valves. For some applications, they seem to be better than the equipment made of corrosion-resistant steels.

A new building recently completed in Pittsburgh used aluminum in many unique applications. Aluminum was used for all water supply piping as well as for most of the air conditioning water pipes. In the layout, a sacrificial pipe is deliberately used to prolong the life of the aluminum pipe. This was put next to the fixtures which were made of copper or brass since very few fixtures are available in aluminum. In addition, special nonconductive gaskets between flanges and around bolts served as barriers to electrolytic current flow. In-

Pump shown has no moving parts and works on magnetic principles. Unit is shown pumping liquid sodium and is located at an atomic power laboratory.



asmuch as sweat fittings cannot be used on aluminum, connections were made with regular flared fittings, and sizes larger than 1½ to 2 in. were welded. The building also used aluminum wiring and buses, as well as aluminum cooling panels.

Many advancements have been made in corrosion control, and the use of cathodic protection is becoming a must in many new plants. This is done either through the use of a d-c source and a graphite ground anode, or without external electric current but with the use of sacrificial anodes of magnesium or zinc.

Field corrosion tests made during the year show that there was a ratio of 20 to 1 difference in atmospheric corrosion between an exceptionally low carbon content ingot iron and a typical low, alloy high strength steel. Intermediate between the two was a copper steel. Thus the material selected is very important in corrosion control.

It is estimated that production of ductile iron totaled 200,000 tons in 1953. This is double 1952 output, and shows the trend to this material.

A new development in automatic hardfacing employs the inert-gas-shielded arc method, and deposits tungsten carbide particles from a vibratory hopper. Advantage of the method is that automatic fast deposition is accomplished. There is a shallow heat affected zone, there is good bonding, and there is little dilution of the carbide particles. The resultant surface is tough and wear resistant.

Welding speeds have been increased, and submerged arc automatic welding machines are operating at rates over 200 in. per minute. The use of two small wires instead of one large wire, with the resultant two arcs, can also increase welding speed very appreciably. This is not the use of two welding heads in tandem, but the use of two wires and two arcs in a single head.

A new arc-torch was developed which is capable of burning holes in solid granite with 8000 F heat. This torch creates its own arc and will attack non-conductive material without a ground connection. Equipment needed is a conventional welding machine and specially-coated arc rods.

Also on the general market during the year was the first three-dimensional flame cutting equipment for scarfing the edges of curved metal pieces in preparation for welded assembly of larger units.

A system for starting internal combustion engines hydraulically was demonstrated during the year. A hydraulic motor is actuated by a fluid pressure charge from an accumulator. The motor is an axial-piston, cylinder-driven, wobble-plate fluid motor which meshes with an automatic drive, which in turn cranks the engine through its ring gear. All this happens when a plunger type valve is depressed by the operator.

What may be the answer to non-flammable hydraulic fluids was put on the market during the year. In addition to being non-flammable, the manufacturer states that the new material is non-toxic. It should be of particular value in the steel industry on such items as ingot manipulators, furnace door closers, hydraulic lift trucks, etc. It is further claimed that the fluid not only has no adverse effects on packings, but it helps increase packing life. Initial viscosity is about 200 SUS. The fluid has been tested by some of the insurance laboratories and found to be an acceptable hydraulic fluid from the fire hazard standpoint.

ELECTRICAL

Generation of electricity by utilities in 1953 set a new high of 441,500,000,000 kwhr. This is 10.6 per cent above 1952. In addition, industrial plants generated about an additional 67,000,000 kwhr. Power use is expected to grow so that by 1965 more than 1,000,000,000,000 kwhr will be used annually. Electric power is one of the fastest growing industries in the country, and has been growing three times as fast as the average growth for all industries. Generating capacity at the end of the year was about 104,000,000 kw of which approximately 18,000,000 is run by government, 14,000,000 by industry, and 72,000,000 kw by private power companies.

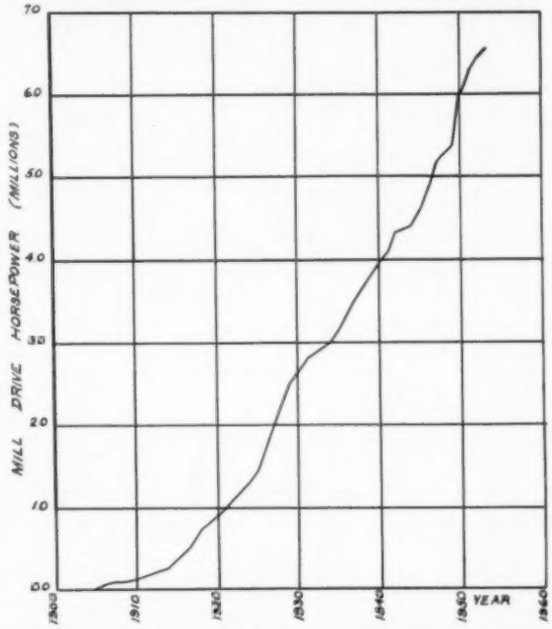
The proportion of electric energy generated with natural gas has more than doubled in the past six years. Water power on the other hand reached a new low record according to preliminary estimates by the EEI for 1953. In 1953, electricity generated by natural gas totaled about 82,000,000,000 kwhr or 18.5 per cent of the total 441,500,000,000 kwhr, whereas hydroelectric production was 105,000,000,000 kwhr in 1953 or 23.5 per cent of the total. A factor in water power this year was the water shortage which was widespread throughout the country. Heat efficiency for generation is increasing. In 1946, the national average for thermoplants was 1,293 lb of coal (or equivalent in other fuels) per kwhr, average consumption at the present time is equivalent to 1.065 lb of coal per kwhr.

The average size of turbine generators in the past ten

Additional rolling capacity has required a great deal of additional electrical drive equipment and control.

years has gone from 50,000 to 90,000 kw. In terms of individual sizes, the largest 3600-rpm machine jumped from 70,000 to 156,250 kw, with a 208,000-kw unit on order. The largest cross-compound turbine unit presently on order is 260,000 kw.

Construction was started on the first large generator with liquid-cooled conductors during the year. This unit has a new method of circulating a liquid through hollow conductors in the stator. Intended for a Cleveland power plant, it consists of a tandem-compound turbine rated at 208,000 kw and a generator rated at 260,000 kva which is one of the largest in the world.



Cumulative curve of main drive motors over 300 hp shows a total to January 1954 of 6,521,140 hp. Seventy-five motors (121,250 hp) were added in 1953, or about 1.7 times the total added in 1952.

Liquid cooling enables design and manufacture of armatures having higher capability than present units. Installation is scheduled by the end of 1955. Several others of the same type have since been authorized.

An interesting development in motor application is the use of outdoor motors so designed that they can withstand exposure and do not require indoor location. As a result, capital costs are kept down. Many of these are used in applications such as pumping stations.

The drives which were installed in each of the two 45-in. reversing universal slabbing mills during the year have the largest hp and torque capacity ever applied to a rolling mill. Upper and lower main horizontal rolls of the mills are separately driven by two 6000-hp, 40/80-rpm, 800-volt, double-armature motors constituting a 12,000 hp twin motor. These have a 1,575,000 lb-ft rated full-load torque capacity, and are capable of developing a maximum total torque of 4,340,000 lb-ft. The two vertical edging rolls are driven through a cross shaft and bevel gears by a 4000-hp, 60/150-rpm, 700-volt motor, also of double armature construction. One of these drives went into operation on the 45-in. reversing universal slabbing mill at Morrisville, and the other at Great Lakes Steel.

The 40-in. reversing blooming mill at Morrisville is driven by an 8000-hp twin drive made up of two 4000-hp, 65/130-rpm, 700-volt, single armature motors.

The new 90-in. hot strip mill at Morrisville is designed for higher maximum delivery speed than any previous mill. Total hp rating and rating of main drive motors exceeds that of any other mill. Nominal speed range of final finishing stand is 1060/2330 fpm, and the total rated capacity of the nineteen motors driving the scale breakers, vertical edgers, and roughing and finishing stands is 60,600 hp. Finishing stands No. 1, 2, 3, 4, and 5 are each driven by a 5000-hp motor and No. 6 by a 4000-hp motor. Power supply comes from ignitron rectifiers.

Under construction at Youngstown Sheet & Tube Co.'s Indiana Harbor plant is a 56-in. four-stand tandem, cold strip mill. This unit is rated at 3500 fpm. Stand No. 1 is driven by a 3000-hp motor, stands No. 2 and 3 are driven by 5000-hp double-armature, direct-connected units, and stand No. 4 is driven by a 5250-hp triple armature, direct-connected unit.

The Sendzimir planetary hot strip mill being built for a Canadian plant will be driven by a 1250-hp, 900-rpm synchronous motor. Feed rolls and up coiler d-c motors are supplied by packaged adjustable speed power units.

Expansion at Colorado Fuel and Iron required the revamping of the 25-in. structural mill to provide semi-finished steel and billets for the tube mill. A new 4000-hp, d-c motor with flywheel motor-generator, slip regulator, switchgear, and control was installed. The new motor is rated 4000-hp, 75/175-rpm, 700-volt. It is direct-connected to the mill pinion stand.

The National Electrical Manufacturers Association approved a new standard line of a-c motors from 1 to 30 hp. This was a rerating program in which the new designs were made smaller than the previous line, taking advantage of the refinements in motor design of the past 25 years, when the previous frame sizes were set. In the line, drip-proof motors are rated at 40 C rise, and fan-cooled motors are rated at 55 C rise. Fewer frames are incorporated in the new line, and in several cases, at least two horsepower ratings per frame for any given speed have been developed. Only five diameters are

Blooming mill installed at Granite City is powered by two 5000-hp twin drive electric motors. It is capable of edging slabs up to 66-in. wide.

used in the range of 1 to 30 hp compared with six in the 1 to 25-hp range previously. In the nomenclature of the line, the first two digits of the frame number are equal to four times the shaft height of the motor. The third digit is approximately equal to one-half the distance between the two longitudinal mounting holes. Although NEMA members are not required to follow the new standards, it is believed that the vast majority will rerate their motors, and after a time they will be producing none of the older frame sizes. Some of the new frame sizes will probably not be in production before 1955.

There has been a definite trend toward grounding of low voltage systems in industrial plants. Among the reasons for this are more positive location of ground faults by tripping out only the affected circuit, and reduction of the possibility of multiple failures of equipment and circuits from overvoltages due to ground faults.

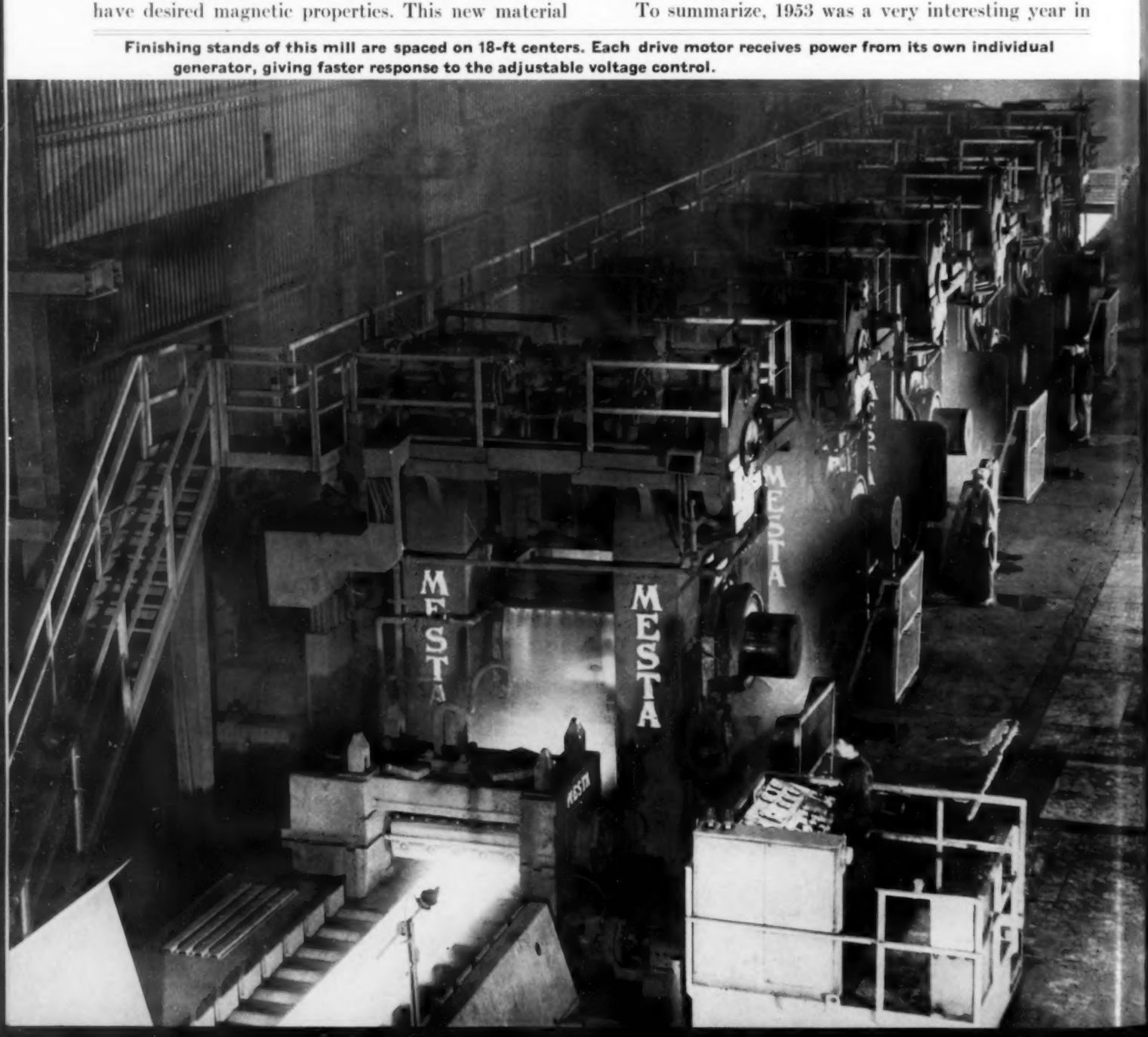
A new magnetic material was developed by the Naval Ordnance Laboratory. This consists of 16 per cent aluminum and 84 per cent iron. Researchers developed a method of cold rolling this at 575 C, and found the alloy could be formed into thin tapes which have desired magnetic properties. This new material should be useful in transformer cores and high-frequency communication instruments.

A process was developed for manufacturing pure silicon. This should lead the way for less bulky electrical and electronic equipment. It is believed that the pure silicon may supplant or compete with germanium in transistor uses. This is particularly true where temperatures of more than 170 F are involved. Pure silicon may also compete with selenium in rectifiers because of its better high temperature properties.

A new type of magnet was developed during the year, composed of ceramic material, which is lighter in weight than metal and requires no critical ingredients. New fields for the use of magnets in industry are expected to be opened by this material. The material is earthy in nature, and non-organic and non-metallic, being iron oxide and barium carbonate. It is magnetized, however, in the same manner as metals, although a much greater magnetizing force is required. It is stated that the material has twice as much coercive force as alnico, having approximately 1,600 oersteds, and an intrinsic coercive force of approximately 4000 oersteds. It is also a non-conductor.

To summarize, 1953 was a very interesting year in

Finishing stands of this mill are spaced on 18-ft centers. Each drive motor receives power from its own individual generator, giving faster response to the adjustable voltage control.



ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1953

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
1	250/650	375/1050	230/600	d-c	Geared	Edger drive of 60-in. mill	Tata Iron & Steel Co., Ltd.	India	General Electric
2	250/650	375/1050	230/600	d-c	Geared	Edger drive of 60-in. mill	Tata Iron & Steel Co., Ltd.	India	General Electric
3	300	300/1200	250	d-c	Geared	Sendzimir reversing cold strip mill	Acme Steel Co.	Riverdale, Ill.	General Electric
4	300	300/1200	250	d-c	Geared	Sendzimir reversing cold strip mill	Acme Steel Co.	Riverdale, Ill.	General Electric
5	300	600/1000	250	d-c	.....	Sendzimir mill	Atlas Steels, Ltd.	Welland, Ont.	Reliance Electric & Engineering
6	350	575/1150	230	d-c	.....	98-in. Strip mill	Republic Steel Corp.	Cleveland, Ohio	Reliance Electric & Engineering
7	400	125/450	250	d-c	Direct	Reel, taper mill	Reynolds Metals Co.	Chicago, Ill.	Westinghouse
8	400	125/450	250	d-c	Direct	Reel, taper mill	Reynolds Metals Co.	Chicago, Ill.	Westinghouse
9	①②400	400/750	350	d-c	Direct	No. 5 Skin pass mill	Wheeling Steel Corp.	Steubenville, Ohio	Westinghouse
10	①②400	400/750	350	d-c	Direct	No. 5 Skin pass mill	Wheeling Steel Corp.	Steubenville, Ohio	Westinghouse
11	400	250/1200	600	d-c	Geared	54-in. Tandem mill winding reel	Inland Steel Co.	E. Chicago, Ind.	Westinghouse
12	400	250/1200	600	d-c	Geared	72-in. Tandem mill winding reel	Inland Steel Co.	E. Chicago, Ind.	Westinghouse
13	*400	180	2300	60	Geared	Bar mill	Vanadium Alloys Steel Co.	London, Ont.	Canadian General Electric
14	500	850/1270	600	d-c	Direct through pinion stand	Sendzimir reversing cold strip mill	Acme Steel Co.	Riverdale, Ill.	General Electric
15	500	175/525	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
16	500	175/612	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
17	500	300/900	600	d-c	Geared	Rod mill	Cia Fundidora DeFierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
18	500	390/900	600	d-c	Geared	Rod mill	Cia Fundidora De Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
19	500	350/700	600	d-c	Geared	Sendzimir reversing cold strip mill	American Brass Co.	Waterbury, Conn.	General Electric
20	500	350/700	600	d-c	Direct	Sendzimir reversing cold strip mill	American Brass Co.	Detroit, Mich.	Westinghouse
21	600	400/1200	600	d-c	Geared	4-High reversing cold mill	American Brass Co.	Torrington, Conn.	General Electric
22	600	400/1200	600	d-c	Geared	4-High reversing cold mill	American Brass Co.	Torrington, Conn.	General Electric
23	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
24	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
25	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
26	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
27	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
28	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
29	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
30	600	350/960	600	d-c	Geared	11-Stand skelp mill	Tata Iron & Steel Co., Ltd.	India	General Electric
31	600	250/750	600	d-c	Direct	Merchant mill	Phoenix Manufacturing Co.	Joliet, Ill.	Westinghouse
32	600	250/750	600	d-c	Direct	Merchant mill	Phoenix Manufacturing Co.	Joliet, Ill.	Westinghouse
33	600	575/1150	600	d-c	Geared	Single stand reversing mill	Blaw-Knox Co.	Pittsburgh, Pa.	Reliance Electric & Engineering
34	600	575/1150	600	d-c	Geared	Single stand reversing mill	Blaw-Knox Co.	Groveton, Pa.	Reliance Electric & Engineering
35	600	575/1150	600	d-c	.....	Foil mill	Aluminum Co. of America	Pittsburgh, Pa.	Reliance Electric & Engineering
36	600	690/1380	375	d-c	Geared	Continuous seamless tube mill	Globe Steel Tubes Co.	Milwaukee, Wisc.	Allis Chalmers
37	600	690/1380	375	d-c	Geared	Continuous seamless tube mill	Globe Steel Tubes Co.	Milwaukee, Wisc.	Allis-Chalmers
38	800	300/600	600	d-c	Geared	24-in. Continuous mill	Bethlehem Steel Corp.	Sparrows Point, Md.	Allis-Chalmers
39	800	300/600	600	d-c	Geared	24-in. Continuous mill	Bethlehem Steel Corp.	Sparrows Point, Md.	Allis-Chalmers
40	800	250/750	600	d-c	Geared	Rod mill	Cia Fundidora De Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
41	800	250/750	600	d-c	Geared	Rod mill	Cia Fundidora De Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
42	*800	180	2300	60	Geared	Bar mill	Vanadium Alloys Steel Co.	London, Ont.	Canadian General Electric
43	900	300/900	600	d-c	Geared	Rod mill	Cia Fundidora De Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
44	900	300/900	600	d-c	Geared	Rod mill	Cia Fundidora De Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
45	1000	575/1150	600	d-c	Geared	Aluminum foil mill	Aluminum Co. of America	Edgewater, N. J.	General Electric
46	1000	575/1150	600	d-c	Geared	Aluminum foil mill	Aluminum Co. of America	Edgewater, N. J.	General Electric
47	1000	300/900	600	d-c	Geared	18-in. x 49-in. x 56-in. Reversing cold strip mill reel	Newport Steel Co.	Newport, Ky.	Elliott
48	1000	300/900	600	d-c	Geared	18-in. x 49-in. x 56-in. Reversing cold strip mill reel	Newport Steel Co.	Newport, Ky.	Elliott
49	1200	186/650	460	d-c	Direct	Reel motor	Wheeling Steel Corp.	Steubenville, Ohio	Westinghouse
50	*1250	514	2300	60	Geared	Piercing mill	Anaconda-American Brass Co.	New Toronto, Ont.	Canadian General Electric
51	1500	350/700	600	d-c	Geared	Rod mill	Cia Fundidora De Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	General Electric
52	1500	250/625	600	d-c	Direct	30-in. Reversing cold strip mill	Algoma Steel Corp.	Sault Ste Marie, Ontario	Canadian General Electric
53	1500	80/200	600	d-c	Direct	Expanding mill	United States Steel Co., National Tube Div.	Lorain, Ohio	Elliott
54	2000	175/350	600	d-c	Geared	66-in. Hot strip finishing mill	Weirton Steel Co.	Weirton, W. Va.	General Electric
55	2000	175/350	600	d-c	Geared	66-in. Hot strip finishing mill	Weirton Steel Co.	Weirton, W. Va.	General Electric
56	2000	175/350	600	d-c	Geared	66-in. Hot strip finishing mill	Weirton Steel Co.	Weirton, W. Va.	General Electric
57	2000	175/350	600	d-c	Geared	66-in. Hot strip finishing mill	Weirton Steel Co.	Weirton, W. Va.	General Electric
58	2250	80	2300	60	Direct	Merchant mill	International Nickel Co.	Huntington, W. Va.	General Electric
59	①2500	40/120	600	d-c	Direct	Blooming mill	Copperweld Steel Co.	Warren, Ohio	Allis-Chalmers
60	3000	125/250	700	d-c	Geared	Reversing taper mill	Reynolds Metals Co.	Chicago, Ill.	Westinghouse
61	①3000	40/100	600	d-c	Direct	60-in. Reversing rougher	McLouth Steel Co.	Trenton, Mich.	General Electric
62	①3000	40/100	600	d-c	Direct	60-in. Reversing rougher	McLouth Steel Co.	Trenton, Mich.	General Electric
63	3000	150/375	600	d-c	Direct	18-in. x 49-in. x 56-in. Reversing cold strip mill	Newport Steel Co.	Newport, Ky.	Elliott
64	3000	125/250	700	d-c	Geared	Reversing taper mill	Reynolds Metals Co.	Chicago, Ill.	Westinghouse
65	3500	175/350	750	d-c	Direct	60-in. Mill No. 6 finishing stand	McLouth Steel Co.	Trenton, Mich.	General Electric
66	5000	175/350	750	d-c	Geared	60-in. Mill No. 2 finishing stand	McLouth Steel Co.	Trenton, Mich.	General Electric
67	5000	90/180	750	d-c	Direct	60-in. Mill No. 3 finishing stand	McLouth Steel Co.	Trenton, Mich.	General Electric
68	5000	125/250	750	d-c	Direct	60-in. Mill No. 4 finishing stand	McLouth Steel Co.	Trenton, Mich.	General Electric
69	5000	150/300	750	d-c	Direct	60-in. Mill No. 5 finishing stand	McLouth Steel Co.	Trenton, Mich.	General Electric
70	5000	40/100	700	d-c	Direct	36-in. Reversing blooming mill	Kaiser Steel Co.	Fontana, Calif.	Westinghouse
71	*6000	360	6600	60	Geared	80-in. Hot strip mill, No. 4 rougher	United States Steel Co.	Dravosburg, Pa.	General Electric
72	②6000	100/250	600	d-c	Direct	56-in. Reversing hot strip	Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	Canadian General Electric
73	*6000	450	6900	60	Geared	54-in. 5-Stand hot strip mill, No. 3 roughing stand	Weirton Steel Co.	Weirton, W. Va.	Elliott
74	*6000	450	6900	60	Geared	54-in. 5-Stand hot strip mill, No. 4 roughing stand	Weirton Steel Co.	Weirton, W. Va.	Elliott
75	*6000	450	6900	60	Geared	54-in. 5-Stand hot strip mill, No. 5 roughing stand	Weirton Steel Co.	Weirton, W. Va.	Elliott

*Indicates synchronous motor

①Twin Motor Drive

②Double armature

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER
(CONTINUED)

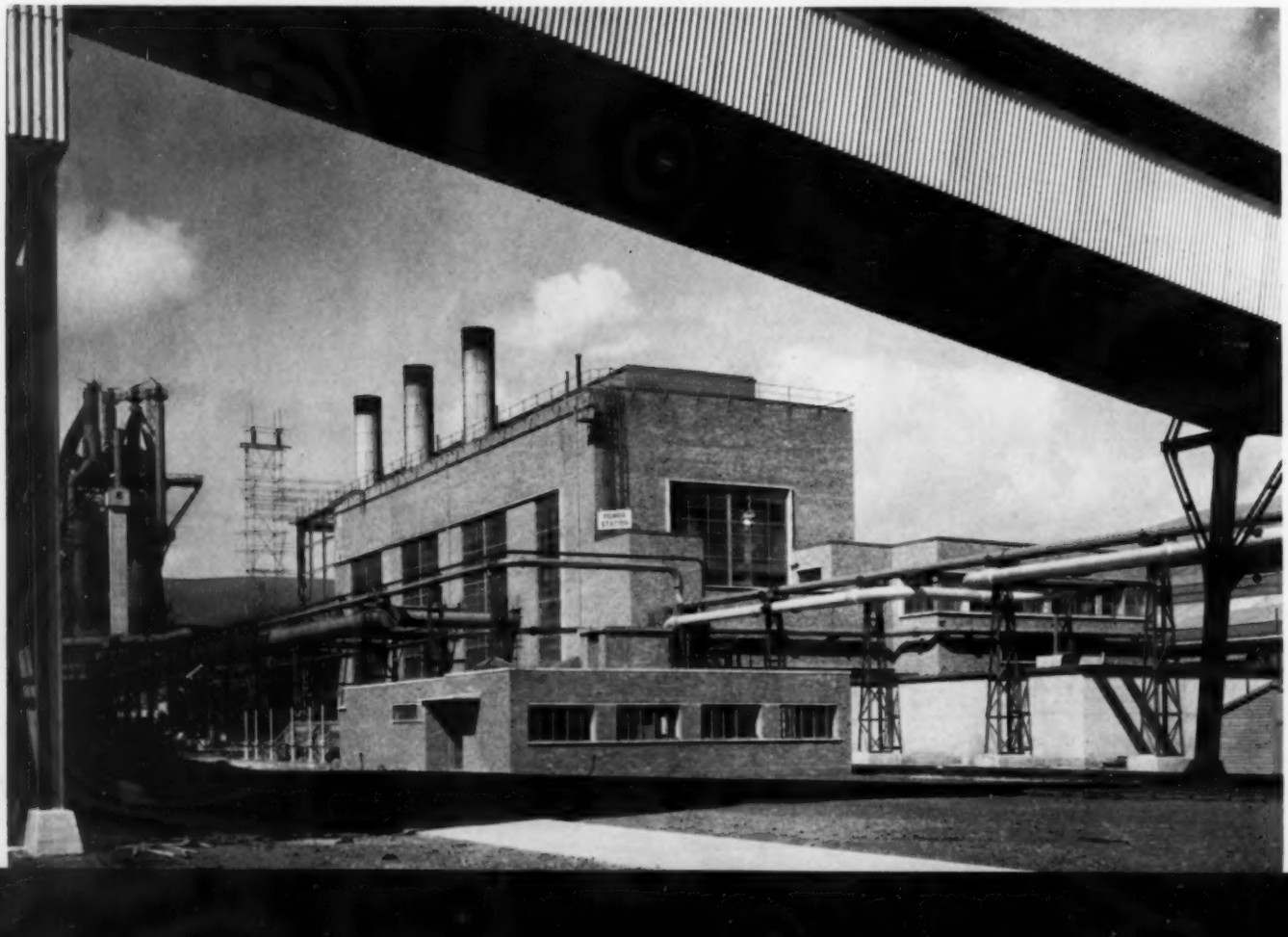
MOTOR RECAPITULATION

Company	*Location*	*Type of mill*	*Number of motors*	*Total horsepower*
Acme Steel Co.	Riverdale, Ill.	Sendzimir reversing cold strip mill	3	1,100
Algoma Steel Corp.	Sault Ste. Marie, Ont.	30-in. Reversing cold strip mill	1	1,500
Aluminum Co. of America	Edgewater, N. J.	Aluminum foil mill	2	2,000
	Pittsburgh, Pa.	Aluminum foil mill	1	600
American Brass Co.	Torrington, Conn.	4-high reversing cold mill	2	1,200
	Waterbury, Conn.	Sendzimir reversing cold strip mill	1	500
	Detroit, Mich.	Sendzimir reversing cold strip mill	1	500
Anaconda-American Brass Co.	New Toronto, Ont.	Piercing mill	1	1,250
Atlas Steels, Ltd.	Welland, Ont.	Sendzimir reversing cold strip mill	1	300
Bethlehem Steel Corp.	Sparrows Pt., Md.	Entry end of 24-in. continuous mill	2	1,600
Blaw-Knox Co.	Pittsburgh, Pa.	Single stand reversing mill	1	600
	Groveton, Pa.	Single stand reversing mill	1	600
Cia Fundidora de Fierro y Acero de Monterrey, S. A.	Monterrey, Mexico	Rod mill	7	5,900
Copperweld Steel Co.	Warren, Ohio	Blooming mill	1	2,500
Dominion Foundries & Steel Co.	Hamilton, Ont.	56-in. Reversing hot strip mill	1	6,000
Globe Steel Tubes Co.	Milwaukee, Wisc.	Continuous seamless tube mill	2	1,200
Inland Steel Co.	E. Chicago, Ind.	54-in. Tandem mill winding reel	1	400
		72-in. Tandem mill winding reel	1	400
International Nickel Co.	Huntington, W. Va.	Merchant mill	1	2,250
Kaiser Steel Co.	Fontana, Calif.	36-in. Reversing blooming mill	1	5,000
McLouth Steel Co.	Trenton, Mich.	60-in. Reversing rougher	2	6,000
		60-in. Finishing stands	5	23,500
Newport Steel Co.	Newport, Ky.	18-in. x 49-in. x 56-in. Reversing cold strip mill	1	3 000
		18-in. x 49-in. x 56-in. Reversing cold strip mill reel	2	2,000
Phoenix Manufacturing Co.	Joliet, Ill.	Merchant mill	2	1,200
Republic Steel Co.	Cleveland, Ohio	98-in. Strip mill	1	350
Reynolds Metals Co.	Chicago, Ill.	Reversing taper mill	4	6,800
Tata Iron & Steel Co., Ltd.	India	Edger drive of 60-in. mill	2	500
		11-stand skelp mill	10	5,800
United States Steel Corp.	Dravosburg, Pa.	80-in. Hot strip mill, No. 4 rougher	1	6,000
	Lorain, Ohio	Expanding mill	1	1,500
Vanadium Alloys Steel Co.	London, Ont.	Bar mill	2	1,200
Weirton Steel Co.	Weirton, W. Va.	66-in. Hot strip finishing mill	4	8,000
		54-in., 5-stand Hot strip mill	3	18,000
Wheeling Steel Corp.	Steubenville, Ohio	No. 5 Skin pass mill	2	800
		Reel motor	1	1,200

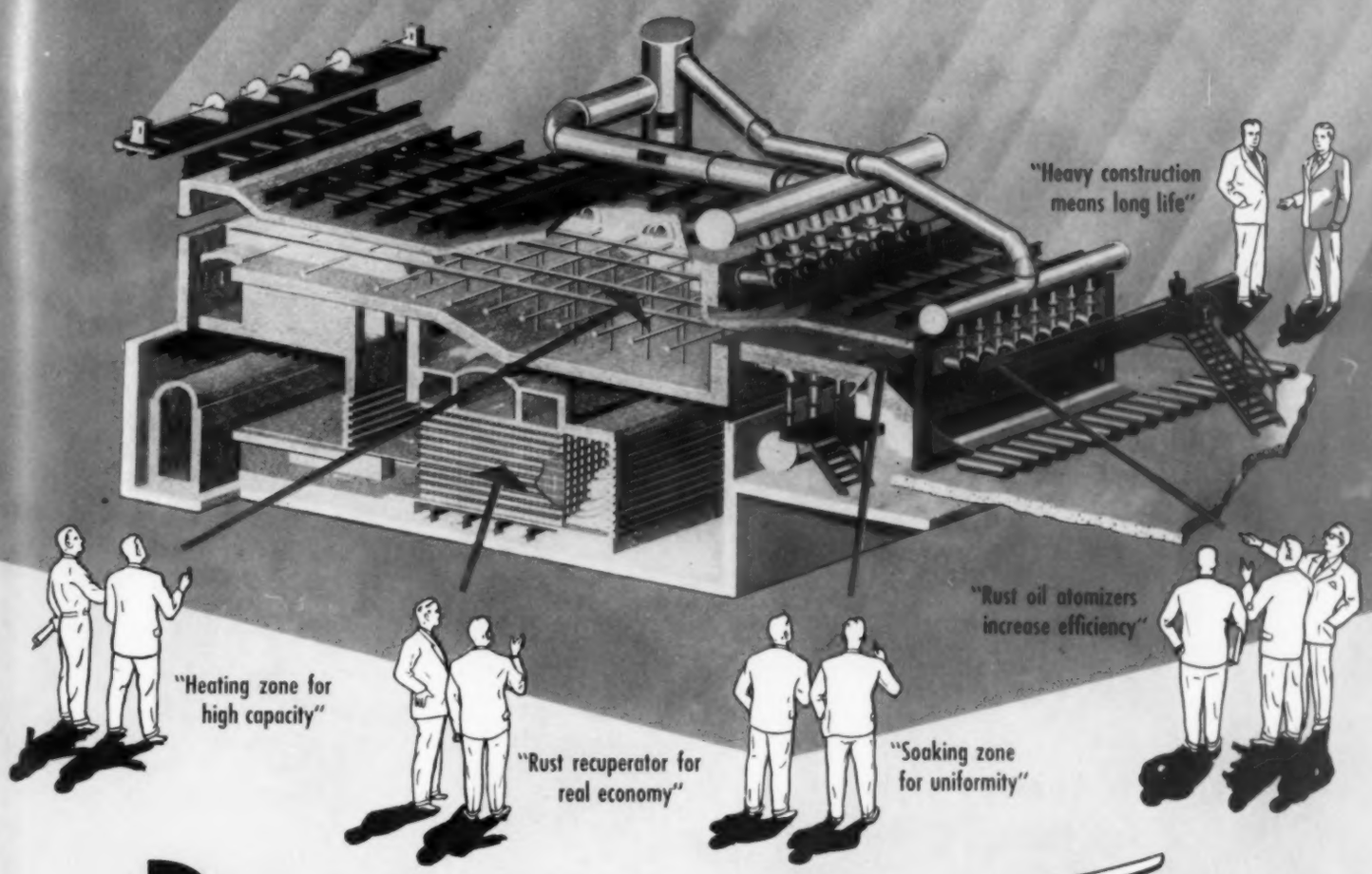
Type of Motors Purchased	*Number of motors*	*Total horsepower*
Alternating current motors	8	28,700
Direct-current motors	67	92,550
Total	75	121,250

the steel industry. It saw the completion of much of the plant expansion which has been under way since the end of the war. Sales of main drives were large by prewar standards, and additional horsepower supplied by main roll drives sold during 1953 totaled 121,250 hp, made up of 75 motors, of which 67 were d-c and 8 were a-c. This is about 70 per cent greater than the sales in 1952.

This power station, located at Margam works, contains two 8000-kw and one 1800-kw turbo-generators.



FURNACE MEN KNOW THEY'RE BETTER


"Heavy construction means long life"
"Rust oil atomizers increase efficiency"
"Heating zone for high capacity"
"Rust recuperator for real economy"
"Soaking zone for uniformity"

RUST *Continuous Reheating Furnaces*

PROVIDE *ACCURATE TEMPERATURE CONTROL*.. FOR SLABS, BLOOMS, BILLETS, BARS, ETC.

Yes, furnace men know the advantages of Rust's patented zone controlled, double or triple-fired, recuperative, continuous furnaces. They give positive, automatic control of heating quality and tonnage output. Each furnace is individually designed to meet specific needs and provides 100% accuracy in the control of predetermined heating temperatures. Flexibility is achieved by simply changing the fuel firing rate in the heating zone. It means maximum heating efficiency with a minimum of fuel.

In addition to reheating furnaces, Rust builds other types (designed for any fuel) for practically all metallurgical heating needs. For either new or modernization projects let Rust quote on your requirements.

THE WHOLE JOB IS ONE JOB WITH A

RUST "PACKAGE" CONTRACT

One contract covers everything . . . from blue print through start up. Rust assumes responsibility for design, manufacture, erection, and is prepared to undertake all phases of the work with its own forces, including wiring and piping. This results in substantial savings . . . One profit instead of pyramiding ones which accrue where many subs are employed.

RUST FURNACE COMPANY

Pioneers in Furnace Design

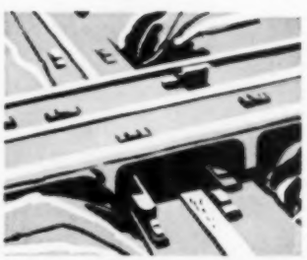
RUST BUILDING **PITTSBURGH, PA.**

For tractors and implements . . .

for cars, trucks and busses . . .

NEW HYATT BARREL BEARING!

You're looking at a cross section of industry's newest find—*the bearing that's built with barrel-shaped rollers!* Developed by Hyatt, the Barrel Bearing is of true dual-purpose design—it takes load from any direction. But more than that, the Barrel Bearing is self-aligning—and misalignment of supporting parts cannot cause excessive wear, as it does with ordinary bearings. Now in volume production, this new bearing is in the newest trucks and busses, in farm, textile and construction equipment, and in many types of oil field machinery. In fact, if you own a new car there's a good chance that Barrel Bearings are in the wheels and differential.



for construction equipment and many types of new machinery.

HYATT

STRAIGHT BARREL TAPER

ROLLER BEARINGS

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

HOW TO CHARGE A REPAIRED BATTERY

▲ USERS of battery-powered industrial equipment such as fork-lift trucks, powerized floor trucks and industrial tractors are sometimes faced with the problem of repairing and recharging damaged batteries or cells. Field service engineers of Gould-National Batteries, Inc., have found that it is of utmost importance to recharge a repaired cell properly before putting it back in service which includes adjusting the electrolyte at the end of the charge.

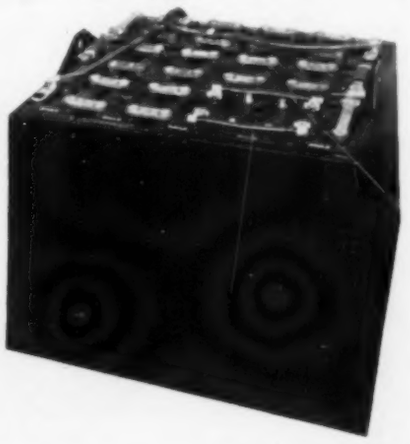


Figure 1 — In this 15-cell battery, cable jumpers with automotive type clamps are used to cut the repaired cell (second from right in front row) out of the circuit while the battery is in service in a truck during working hours.

The best method requires separate charging equipment to give the repaired cell the extra charge that it will need to restore it to operating condition. If the cell has been allowed to dry out because of loss of electrolyte, the cell needs a prolonged charge at the finish rate. In other words, a cell rated at 400 ampere hours which has dried out considerably might require 1200 ampere hours of charge. Therefore, damaged cells should be repaired as quickly as the damage is discovered to eliminate this necessity for excessive charging which results in the battery being out of service for a long period of time.

The amount of charge can be determined by taking a reading of voltage and gravity at the end of the normal charge and every hour after that for four hourly readings. If the readings remain constant for four hours, the cell can be returned to normal duty. If the readings vary, additional charging at the finish rate should be given until the readings remain constant for four hours.

A badly damaged or shorted cell that does not give constant reading of voltage and gravity over a four hour period after repeated efforts should be discarded.

In all cases, the specific gravity of the repaired cell must be adjusted to the proper value after the cell has been recharged.

In many plants it is not possible to arrange for special charging. Where only the regular charger is available for both normal and repaired batteries, the repaired cell can be suitably charged by cutting the cell out of the circuit during operation of the equipment (Figure 1) and putting it back in during charging (Figure 2). As an example, a repaired cell would be placed in the battery, but not connected into the circuit while the truck is in service. At the time the entire battery is recharged the cell is connected into the circuit. This procedure should go on for at least two charging cycles to allow the repaired cell to gain the additional charge required after repair.

To do this, two 18-in. jumpers made of No. 4 rubber covered cable can be used with automotive type clamp terminals soldered on each end. The posts of the repaired cell and the adjoining cells must be built up to fit the terminals.

Figure 2 — During normal charging of the battery, the jumpers are connected to the repaired cell so that the repaired cell receives the normal charge when the entire battery is charged. A damaged and repaired cell should receive at least two charging cycles before the jumpers are removed and the cell is permanently connected back into the battery circuit.

NEW UNLOADING TOWER GOES INTO OPERATION ON BALTIMORE PIER

▲ WHAT is said to be the fastest ship-unloading tower on the Atlantic Coast began operations recently at the Canton Railroad Pier in Baltimore, Md. Designed, fabricated and erected by Heyl & Patterson, Pittsburgh, Pa., the new tower is capable of unloading ore from ships or barges at the rate of 1900 tons per hour. The unloader can dig from ships on either side of the pier and discharge the ore into railroad cars on the pier track or onto a conveyor belt system.

The unloader can travel the entire length of the 1250-ft pier to unload ships from any spot. When traveling, the aprons of the unloader can both be raised to clear the superstructure of ships.

This newest unloading tower incorporates the latest engineering and construction designs including variable voltage control for smoother, better-controlled operation; a turntable trolley to enable the bucket to dig in the ship's hold from any angle; and power-operated rail clamps for added safety.

This is the third unloader put into operation on the Canton Railroad pier and the second built by Heyl & Patterson. The new unloader is capable of unloading more ore than the other two unloaders combined. With the three unloaders working together, the Canton pier now has a rated unloading capacity of over 3000 tons per hour.

The Canton ore pier is operated by The Cottman Co. and is located on the north bank of the Patapsco River; it is 90 feet wide and extends 1253 feet south into the river. Four railroad tracks, each holding 35 hopper cars, run the length of the pier. Vessel berths along the west apron have 39 feet of water, as do the approaches from the main Cape Henry to Fort McHenry channel.

This pier was originally designed to provide two electric unloading towers, spanning the four railroad tracks, and able to traverse the length of the dock to unload ships from any spot. The unloaders weighed the ore and discharged it directly into open

Figure 1 — General view shows ore pier of the Canton Co. of Baltimore.

UNION CHARGING BOXES and PEELS
cast in nickel UNIVAN steel

Quality of Univan Castings improved when Nickel came off restricted list!

Since restrictions were lifted on nickel, you can get even tougher, longer-life charging boxes—cast in nickel UNIVAN steel.

This special alloy steel has definite advantages over carbon steel. For instance, due to its nickel content, UNIVAN has greater resistance to firecracking. And its high tensile strength provides greater resistance to torsional twist and shock.

So, if you're having trouble with excessive firecracking, distortion or breaking of your present castings, UNIVAN castings may be the answer to your problem—whether they be charging boxes, peels, bearing covers, couplings and spindles, tongs and tong levers.

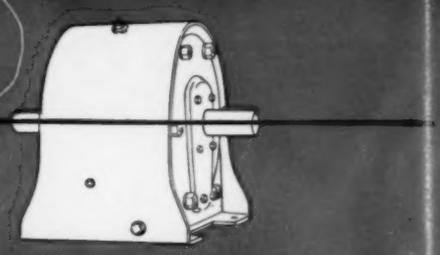
We'll be glad to give you more information about the performance of UNIVAN castings on the toughest jobs. Or, if you want prompt service, just send us your blueprints for a quotation.

BLAW-KNOX COMPANY • • • UNION STEEL CASTINGS DIVISION
PITTSBURGH 1, PENNSYLVANIA

UNION PRODUCTS: charging boxes • peels • bearing covers • slag pots • tongs and tong levers • universal couplings and spindles • gears and pinions • ingot cars • charging box cars • special UNIVAN and ARMOR steel castings.

BLAW-KNOX

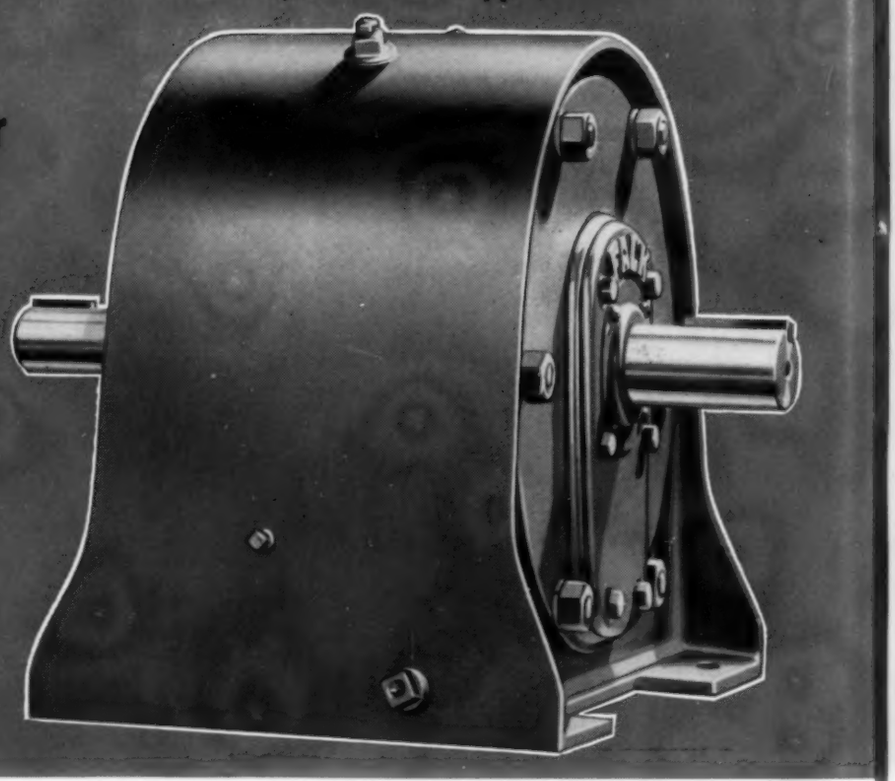
The versatile, STRAIGHT LINE

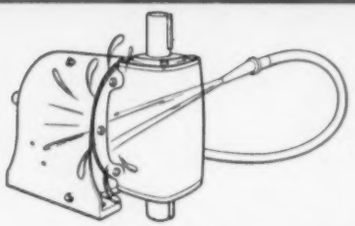


ALL-STEEL FALK SPEED REDUCER

(Concentric Type)

High and low speed shafts suitable for V-belt, gear or chain as well as coupling connections





The Type "C" Speed Reducer has these "In-built" Factors:

Sealed Housings. Dual closures and one-way vents keep oil in, dust and moisture out. Units are splash-proof, leakproof, dust-proof.

Positive Lubrication. Large sump capacity . . . oil-tight construction assures clean lubricant . . . direct dip of revolving elements provides positive lubrication at all speeds.

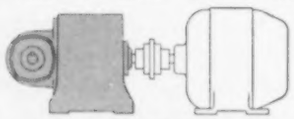
Precision Gearing. Heat treated alloy steel, precision cut and shaved helical gearing throughout . . . quiet-operating crown shaved pinions . . . taper bored gears for easy ratio changes.

Wide Speed Range. Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

All-steel Housings. Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

Streamlined inside and outside. Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

A FEW TYPICAL DRIVES FOR "C" AND "CB" UNITS



COUPLING TO "CB" UNIT

V-BELT TO "C" UNIT

CHAIN TO "CB" UNIT

Write for Bulletin 1104

The ideal type for Turbine, Engine or Special Motor

Here is an exceptionally versatile member of the famous FALK line of reduction units. The Type "C" Straight Line Speed Reducer is an all-steel concentric shaft unit rated in accordance with AGMA standards. It is structurally similar to the universally popular FALK Motoreducer, and offers many special application advantages.

It can be driven by motor, turbine or engine with direct coupling connection—or through a V-belt or chain drive. It lends itself effectively to hydraulic coupling, brake-wheel or overload protective coupling, multi-speed transmission, or to variable speed drives—without modification. Units can include self-contained backstop if desired. Ratio can be modified with easily installed stock gears. With modifications, unit can be used as a speed increaser.

These all-steel Straight Line Speed Reducers are *available for prompt delivery* in standard ratios in horizontal and vertical concentric models, also in horizontal and vertical right-angle models; in single, double, triple and quadruple reduction. For full details, write for Bulletin 1104.

FALK

. . . a good name in industry

THE FALK CORPORATION · 3001 W. Canal St. · Milwaukee 8, Wis.

top cars. Many cargoes arriving in Baltimore contain two or more kinds of ore and varying grades of the same ores. Direct discharge permits the simultaneous unloading of these different ores and eliminates the possibility of commingling separate consignments.

In 1952 the east apron of the pier was enlarged to support a 1664 foot long conveyor belt system which feeds into a storage and weigh hopper north of the dock. The conveyor provides faster discharge for the increasing number of single grade of ore cargoes because the 1500-ton storage hopper allows the towers to continue full speed digging while train crews replace loaded cars with empties. The conveyor belts were designed to handle 3000 tons per hour — the "free digging" output of the towers then in service together with that of the new unloader planned for 1953.

Figure 2 — New tower shows aprons raised.

NEW UNLOADER

Tower Number 3 weighs approximately 1035 tons, of which 750 tons is structural steel and 285 tons is machinery. It is a portal type structure with two hinged aprons, which can be raised to clear a vessel's superstructure while the tower moves from one hatch or vessel to another. The aprons support rails for the bucket trolley runway and permit a bucket travel of 76 feet beyond the centerline of the west columns and 72 feet beyond the centerline of the east columns. Total bucket travel is approximately 210 feet.

This new unloader incorporates the latest design and engineering in bucket handling equipment. Duplicate drives for holding and closing drums have replaced the single motor and clutch assembly. Low inertia mill motors and adjustable voltage control permit the use of larger buckets on a faster cycle with better bucket control and a much lower power consumption than is possible with constant potential d-c power. These features not only result in less damage to ships but assure greater reliability and reduced maintenance both electrically and mechanically.

To improve the "clean-up" efficiency, the bucket, together with its hold and close motors, has been mounted on a turntable type trolley which permits the operator to rotate the bucket 105 degrees in either direction.

An anemometer attached to the east apron mast records wind velocity, operates a warning signal, and prevents tower traverse during hazardous periods by breaking the traverse control circuit when wind velocity exceeds 38 miles per hour. The Heyl and Patterson automatic rail clamps are interlocked and automatically actuated by the anemometer.

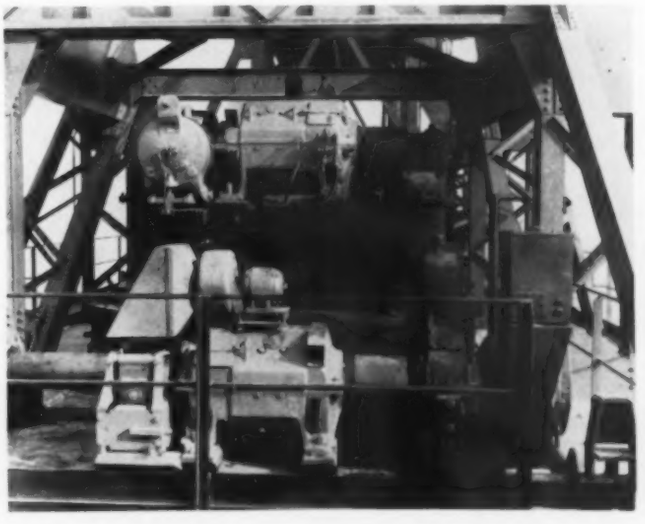
CAPABILITIES OF NEW UNLOADER

Number 3 tower has an operating cycle of 38 seconds based on a mean bucket hoist of 60 feet, a mean bucket travel of 50 feet, and a bucket load of 20 tons. The approximate speed of bucket hoist is 420 fpm and of bucket lowering 500 fpm. Bucket trolley travel is 600 fpm. The trolley is designed to handle a bucket of 280 cu ft, which is equal to 22 tons of ore weighing 157 lb per cu ft. Apron hoist time from the vertical to horizontal position is 3½ minutes. Tower travel is 90 fpm. Under conditions which permit the bucket to grab 20 tons at each bite every 38 seconds, this unloading tower is capable of discharging a vessel at the rate of 1900 tons per hour.

The Cottman Co. has tremendous flexibility in planning the discharge of a cargo. They can concentrate as many as three towers on a single ship, using to best advantage either the conveyor system or direct discharge. Even with a vessel at each berth, they expect to turn full cargo Liberty ships in 18-24 working hours and Victories in 22-28 hours. Collier type vessels, which need less hand stevedoring, will require 8-12 working hours for 10,000 tons, 10-15 hours for 15,000 tons and 13-18 hours for 20,000 ton carriers.

Figure 3 — View shows lower portion of unloading tower including worm-driven trucks and weigh hopper cab.

Figure 4 — View of unloading tower shows turn-table.



Commander Mills, Inc., Sand Springs, Oklahoma

Chief Electrician, Wm. Bert Peacock, Speaking . . .

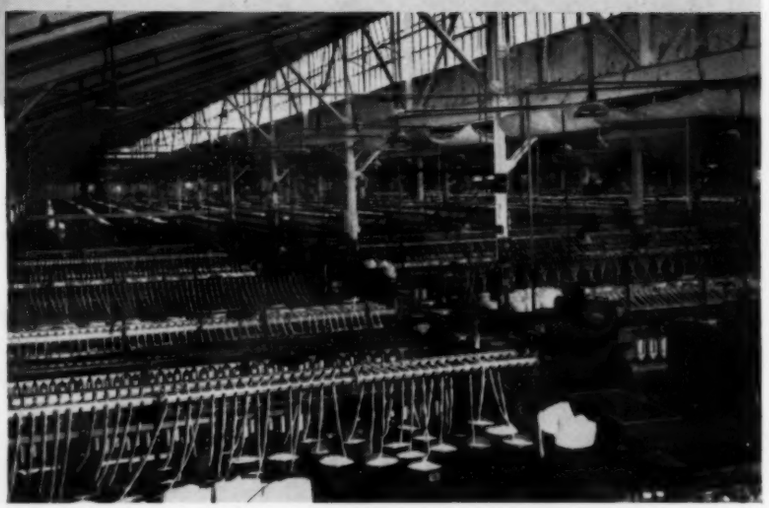
"Protecting motors with FUSETRON fuses is saving us about $6000.00 per year."

"We have a thousand looms, 90 of which are powered by 1 hp motors, 180 by 1½ hp, 100 by ½ hp, 630 by ¾ hp. Prior to 1949 several hundred of these were rewound each year. In fact, they carried them out by the truck loads to the motor rewind shop.

We started using Fusetron Fuses in the winter of 1949 and began to keep individual records on motors. The reduction on motor burn-outs was immediately noticeable. In 1950 only 44 loom motors were repaired.

There is no way to know how much damage was done to motors prior to our new system of maintenance, and it is my belief that some motor repairs now are due to partial damage done prior to 1949.

"In the entire plant we have over 2,500 motors, representing a little more than 5,000 hp connected load. The following list shows our actual expenses on motor repairs:"



"YEAR OF REPAIRS	NUMBER OF MOTORS	AMOUNT
1949	(No Record Kept)	$6,804.00
1950	87	2,796.20
1951	59	2,640.44
1952	63	2,165.63
1953 (1st 6 mos.)	23	445.84

	NUMBER OF MOTORS	DATE OF REPAIRS	AMOUNT
BREAKDOWN OF RECORD FOR MOTOR REPAIRS FOR PAST 6 MONTHS:	3	JAN.	$ 76.37
	4	FEB.	88.62
	3	MAR.	70.62
	4	APRIL	87.75
	4	MAY	101.86
	2	JUNE	20.62
			$445.84 "

Commander Mills, Inc., Sand Springs, Okla.

Superintendent W. R. Swafford, *in charge of Manufacturing, says:*

"WE AVOID UNNECESSARY SHUTDOWNS AND PREVENT MOTOR BURNOUTS BY USING FUSETRON FUSES"

"In the sewing room we have 70 machines using ½ hp, 3-phase motors.

"They are all equipped with Fusetron fuses rated at 3.2 amperes. Formerly, we used 30 ampere fuses to avoid unnecessary blowing on the starting surges of the machines.

"The Electrical Department installed these smaller Fusetron fuses several years ago, and we have not had any trouble with blowing them needlessly and neither have we had any motor burnouts.

"We believe it better to blow a fuse than burn out a motor!"

FUSETRON is a trademark of the Bussmann Mfg. Co., Division of McGraw Electric Co.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

You too, can profit by the 10 POINT PROTECTION of FUSETRON dual-element FUSES

1*Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

*Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

FOR MORE INFORMATION *use this Coupon*

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me complete facts about FUSETRON dual-element Fuses.

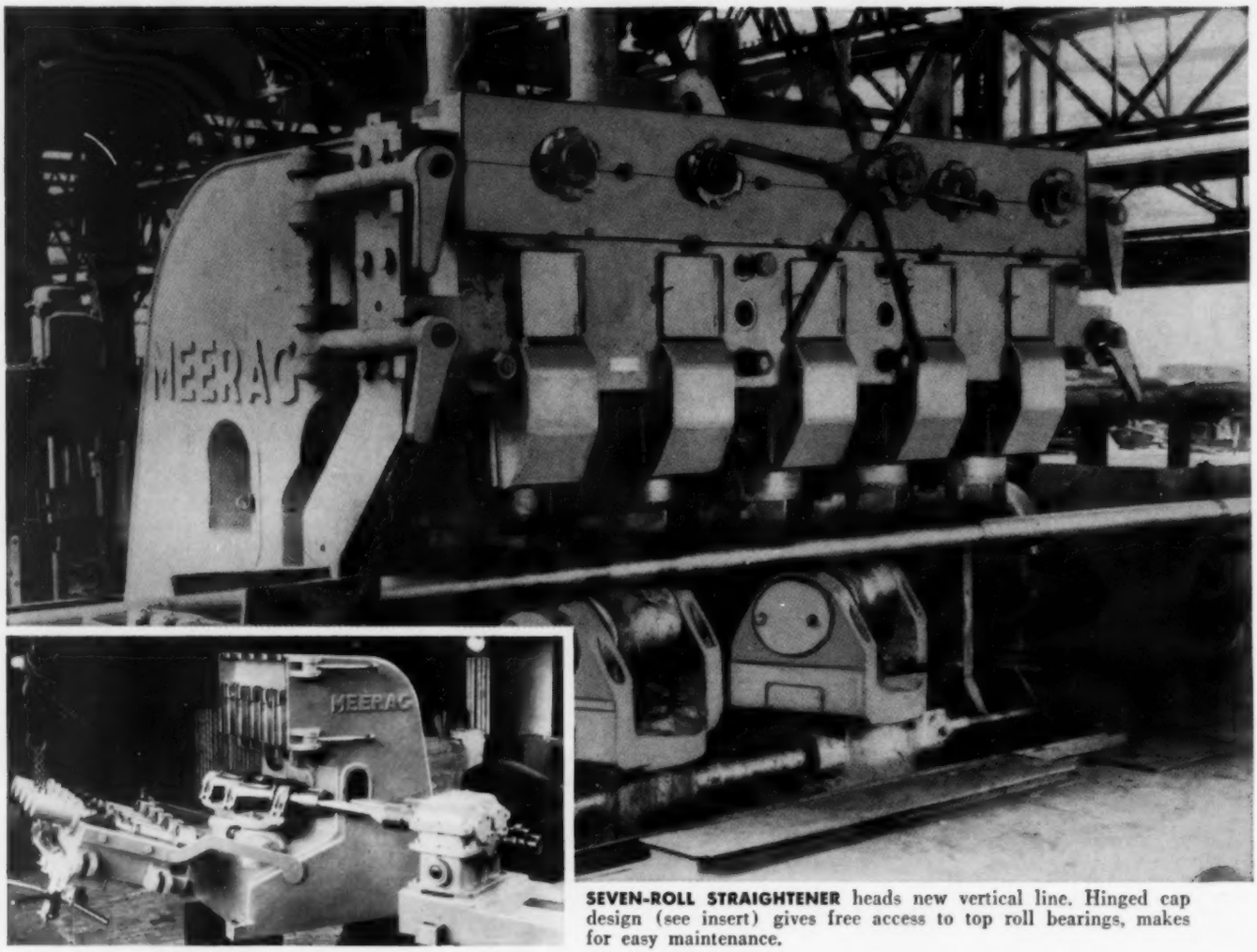
*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City & Zone*_____ *State*_____ 154



SEVEN-ROLL STRAIGHTENER heads new vertical line. Hinged cap design (see insert) gives free access to top roll bearings, makes for easy maintenance.

New straightener line speeds mill production

• Straighten tubes and bars at high speed in a single pass without yield marks? Handle a wide range of stock sizes with each set of rolls? You can do both with one of the new Mannesmann-Meer vertical skewed roll straightening machines.

The large number of these Meer rolls and their special hyperbolic shape improve the surface quality of the work piece, and prevent yield marks which ordinarily result when stressing material through the elastic limit. Vertical arrangement of the rolls helps speed production by keeping bottom level of the straightened material constant for easier access to inlet and outlet tables. All rolls and shafts are supported in anti-friction bearings, and perfect synchronization is insured by a special Mannesmann-Meer drive.

For complete information on vertical or horizontal straightening machines, or any mill machinery for the high-speed production and finishing of pipe and tubing, write to the address below.

M.3.5

MANNESMANN-MEER
ENGINEERING & CONSTRUCTION COMPANY
900 Line Street, Easton, Penna.

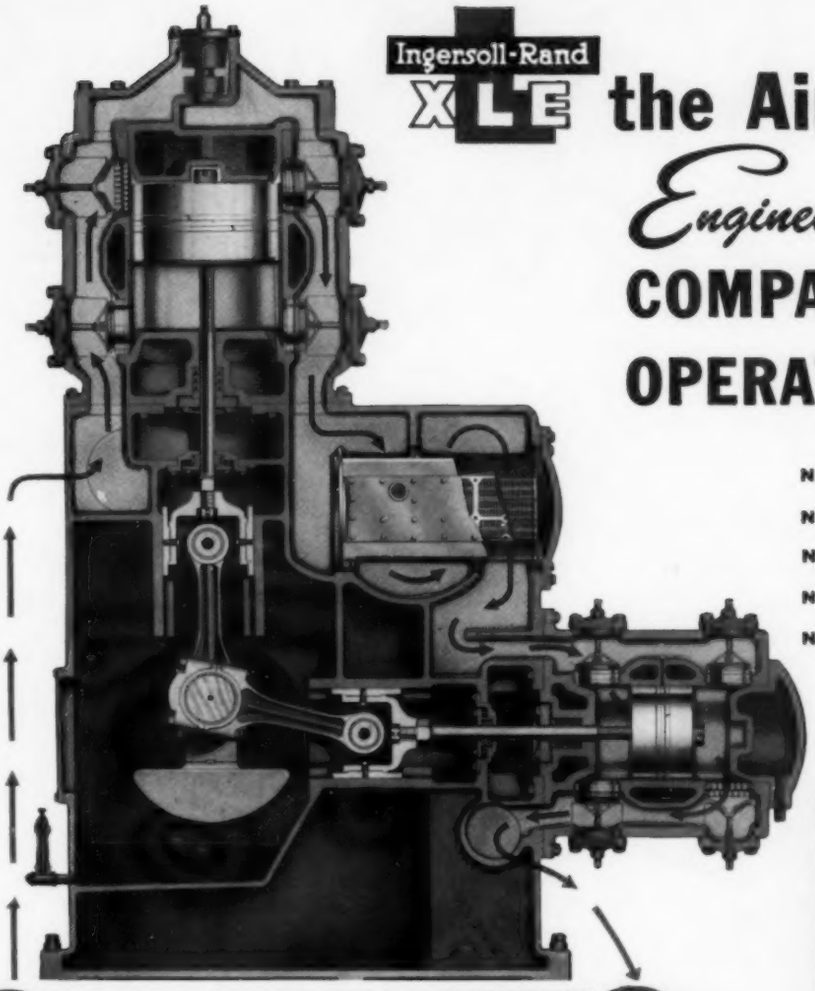
WORLD SPECIALISTS IN HIGH-SPEED TUBE-MILL MACHINERY

Ingersoll-Rand

XLE the Air Compressor

Engineered for

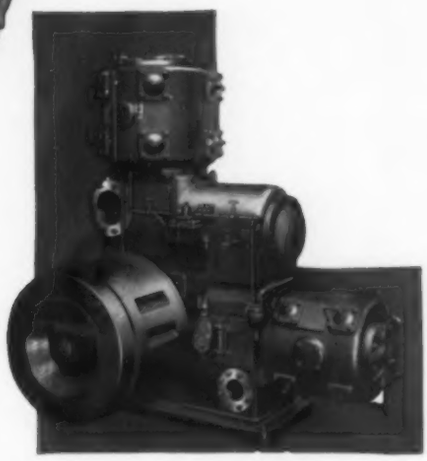
COMPACTNESS AND OPERATING ECONOMY



NEW *Air Flow* DESIGN
NEW *Intercooler* DESIGN
NEW *Cylinder* DESIGN
NEW *Frame and Running Gear* DESIGN
NEW L DESIGN

PIPELESS THRU-FRAME AIR FLOW

Main air connections on the compressor frame eliminate piping strain from the cylinders. Air flow between these two points is entirely within the frame and cylinders. There is no interstage piping. The streamlined frame houses the intercooler and combined with the wide-flanged cylinders provides a sturdy construction that maintains alignment.



Packaged design for minimum floor space, and specially balanced for minimum foundation . . . ideal for skid-mounting.

Easy to operate . . . push button starting, grouped controls, automatic force-feed lubrication, automatic condensate removal, automatic air-operated starting unloaders and capacity control.

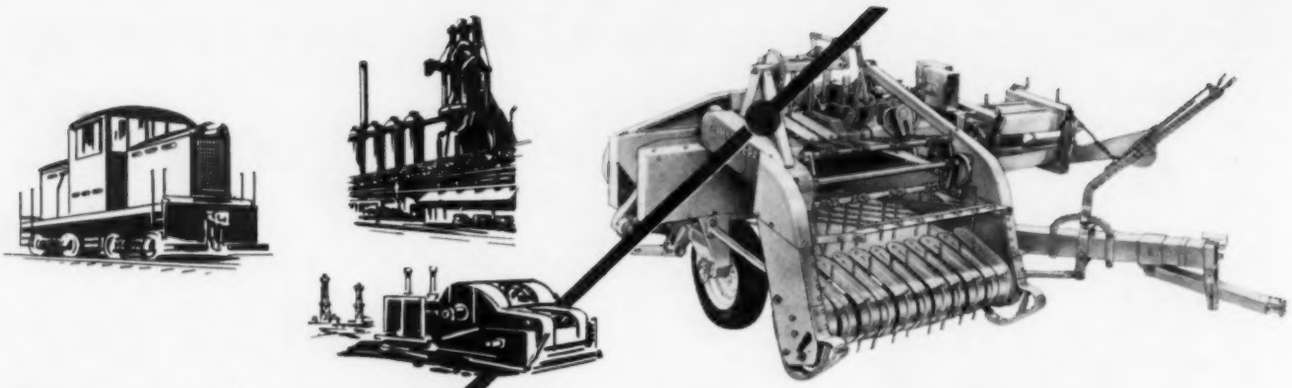
Easy to install or relocate . . . ready-to-run, assembled shipment . . . simplified air and water piping.

Easy to maintain . . . simplified long-life construction . . . full-floating, cool-running, aluminum-alloy bearings that require no adjustment . . . no need to open the sealed crankcase which stays clean inside . . . streamlined exterior also easy to keep clean.

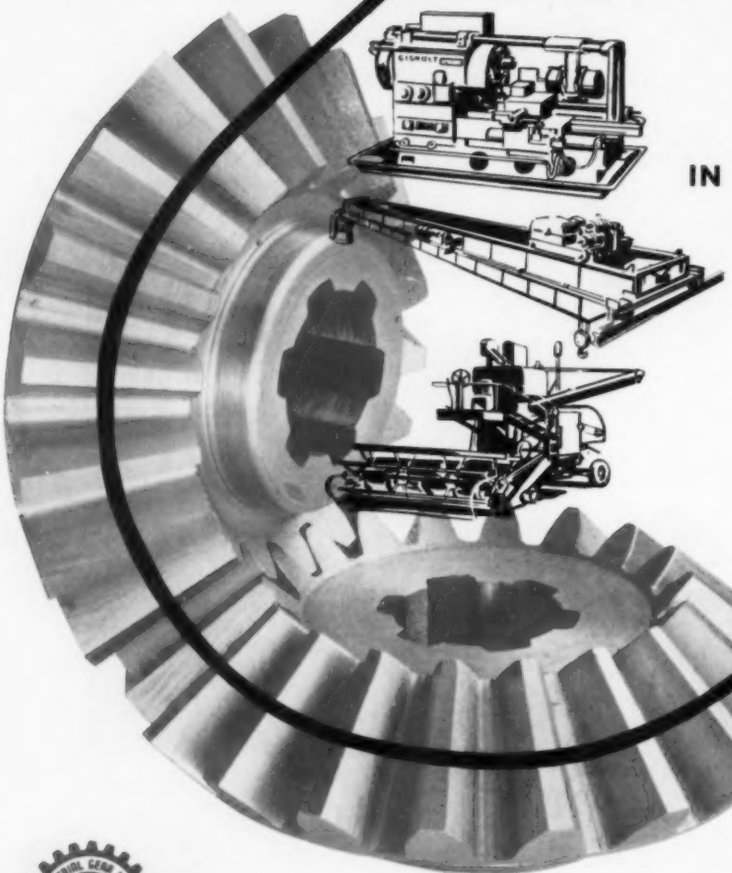
Low operating costs . . . new high-efficiency, long-life I-R Channel Valves result in compressor efficiency comparable to the largest units . . . durable, high-efficiency tube-and-fin intercooler saves water . . . efficient direct-connected motor.

Built for reliable, continuous full-load service . . . sizes 125, 150, 200, 250, 300, 350 horsepower . . . discharge pressures 80 to 125-psi, two stage . . . write for more information today.

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y. 688-1



Industrial Cut Gears

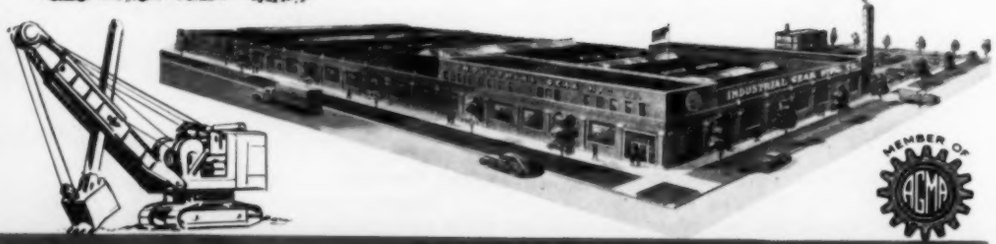


PLAY AN IMPORTANT ROLE IN THE PICKUP, FEED AND WIRE-TYING MECHANISMS OF JOHN DEERE AUTOMATIC HAY BALERS

The end result of John Deere Hay Balers is a nice trim, leafier and more nutritious bale of hay formed speedily and compactly with minimum labor and power. Among its components are "Industrial Cut Bevel Gears" which make this essential implement of farming function smoothly and efficiently.

"Industrial Cut Gears" are important adjuncts in hundreds of mobile and stationary pieces of equipment. They are tailored to fit each application perfectly, hence assure long, dependable service with minimum maintenance cost. "Industrial Cut Gears" will prove to be the economical answer to your drive problems too! It will pay you to write "IG-Durocase" (Steel Mill Type Gears) or "IG-General Service Gears" into your specifications. They'll fulfill your every expectation.

Our modern plant grew to large proportions because of the service we render . . . and because gear and sprocket cutting is our bread and butter—not a sideline. Write for Bulletin No. 152-A and see how well equipped we are to handle your needs.

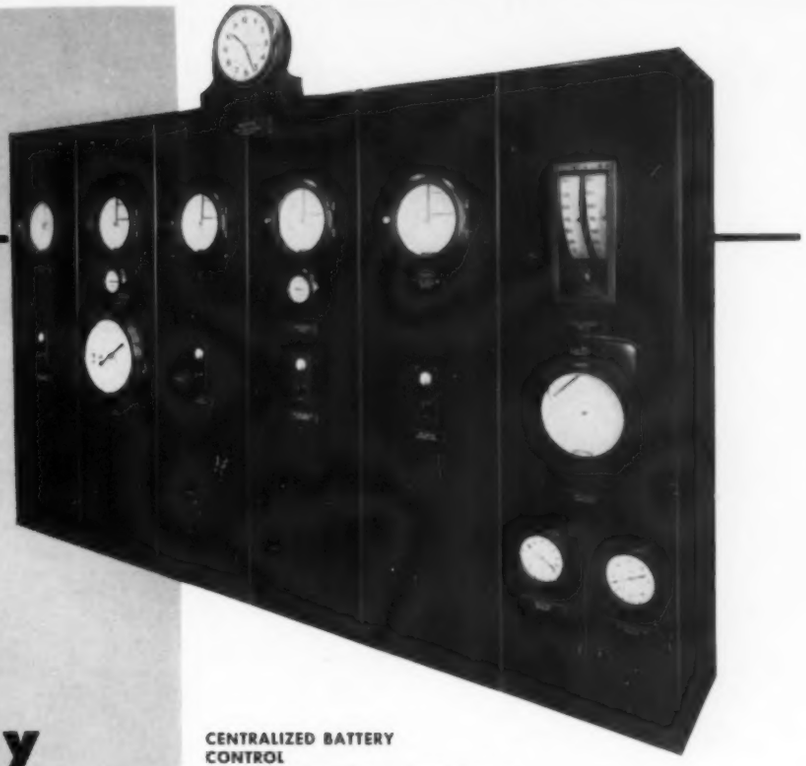


Industrial Gear Mfg. Co.

4527 W. VAN BUREN ST.
CHICAGO 24, ILLINOIS

Newest

REPUBLIC CONTROLS installed on coke battery



CENTRALIZED BATTERY CONTROL
at this panel permits an operator to coordinate automatic regulators controlling stack draft, fuel gas volume and pressure and blast furnace gas pressure. Gages and regulators monitor the system.

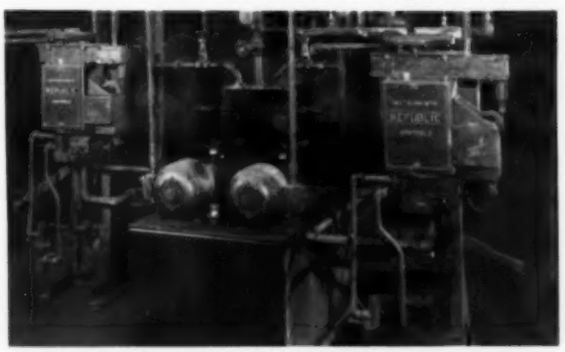
When a new coke battery was added to the coke plant of a mid-western steel mill, Republic electrically controlled hydraulic regulators were installed to control the additional capacity. These new type regulators supplement Republic-Smoot regulators which have been in operation on some of the older batteries for more than 34 years. Dependability, the determining factor in the selection of the new equipment, was more than proven by the performance of the older controls.

The same features—ruggedness and simplicity—which kept these controls in continuous service year after year are embodied in modern Republic Instruments and Controls. That's why Republic equipment remains dependable, regardless of dirt, heat, shocks and vibration. It's also why steel mills such as this one specify Republic, again and again.

GET ALL THE FACTS ABOUT REPUBLIC INSTRUMENTS AND CONTROLS FOR STEEL MILLS

- **ELECTRIC FLOW METERS** for continuous integration and fast transmission of flow information
- **PNEUMATIC ELECTRIC FLOW METERS** for oxygen scarfing and dirty gases
- **LOW PRESSURE RECORDERS** for open hearths, soaking pits, coke ovens, reheating furnaces, smelting furnaces
- **HIGH SPEED POSITIONING OPERATOR** for furnace doors
- **FURNACE PRESSURE REGULATORS**
- **FLOW REGULATORS**
- **BTU TOTALIZERS** for more efficient operation of open hearth furnaces

Write for literature on any of the above



ELECTRICALLY CONTROLLED REGULATORS. The control point of these Republic hydraulic type regulators is set electrically from control panel. In case of failure of hydraulic system, oil trapping valve will lock the regulators in their last position before failure. Electrical failure or accidental shorting of the transmission lines will not cause regulators to shift their control setting.

STILL IN SERVICE AFTER 34 YEARS. These old type Republic-Smoot regulators were installed in 1919 when the coke batteries were built. They operate on the force-balance principle, which permits strong, durable construction without loss of accuracy or sensitivity. This same operating principle is used in modern Republic regulators and pneumatic transmitters.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

ALESTA
679

PACE-SETTER FOR STEEL LEADERSHIP

The pace set by the soaking pits regulates the whole operation of a steel mill. When the pits deliver steady tonnage of evenly heated ingots, you have profitable producing units, and the rest of the mill can run economically and efficiently.

This dramatic picture shows five batteries of Surface Combustion soaking pits at Jones & Laughlin Steel Corporation, one of the leaders in steel. It could be duplicated all across the steel industry, where 'Surface' equipment has paced production for years. The Jones & Laughlin pits are equipped with the famous 'Surface' jet pump, which made history a few years ago by providing maximum recovery of heated air, and is still out front in the industry.

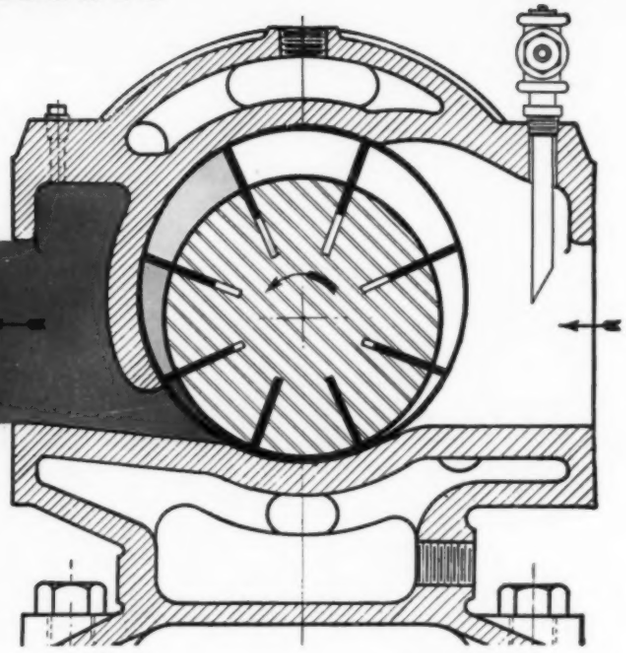
This is an example of the many advances our engineers have made on all 'Surface' equipment—furnaces, annealing covers, and prepared atmosphere generators as well as soaking pits. It explains why steel leaders specify 'Surface.'

Surface
STEEL MILL FURNACES

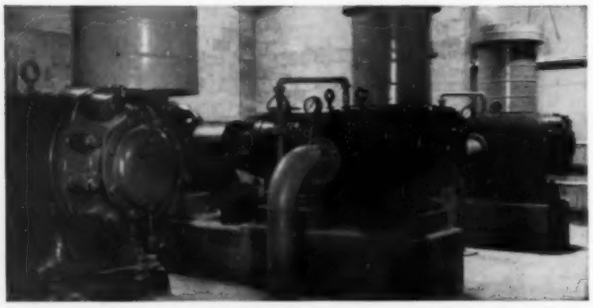
SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

One-way fired soaking pits • Billet reheating furnaces • Slab heating furnaces • Continuous type, controlled atmosphere strip annealing and normalizing furnaces • Controlled atmosphere annealing covers for wire and rod • Controlled atmosphere annealing covers for coil and sheets • Continuous furnaces for heat treatment of steel plate • Controlled atmosphere furnaces for carbon correction in high alloy rod and bar stock • Continuous type bright annealing and normalizing furnaces • Prepared gas atmosphere generating equipment • Pit type convection furnaces for rod annealing • Stress relief furnaces • Wire patenting furnaces

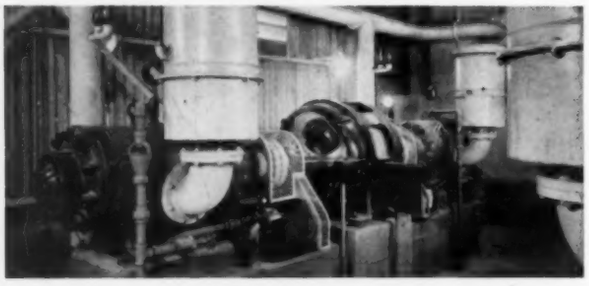
Fuller Rotary Compressors put the SQUEEZE on compression costs



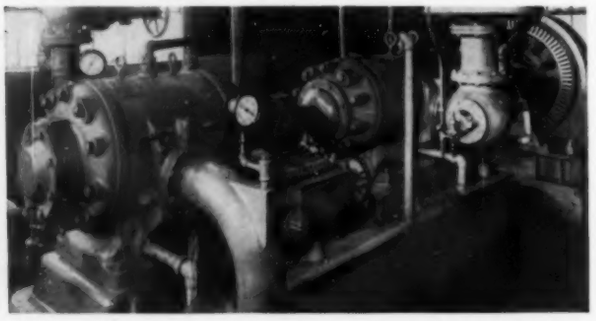
...for pressures up to 125 lb.



Three Fuller Rotary Single-stage Compressors. Capacity each 1400 c.f.m., 19-lb. pressure.



Fuller Rotary Single-stage Duplex Compressor. Capacity 2010 c.f.m., 35-lb. pressure.



Fuller Rotary Two-stage Compressor. Capacity 1665 c.f.m., 100-lb. pressure.

When you consider all the many uses you have for compressed air, you should give careful thought to the best way to get compression with dependability, plus minimum cost and attention —selection of the proper compressor at the required pressures to do the work in the most efficient manner. Fuller builds the compressor that has *earned* a reputation for dependability and long life—for pressures up to 125 psig.

Fuller Rotaries have so many inherent advantages that they warrant your closest examination. Free from reciprocating parts, with no valves to leak or seats to grind, no unbalanced forces to set up vibration, they assure low-cost, smooth-flow operation during their long life. And, they give you *original, maintained capacity*.

Check your compressed-air needs . . . a Fuller engineer, specializing in compressed-air engineering, will give you the *right* recommendation to enable you to produce air efficiently, and at the lowest possible cost. Write now.

FULLER COMPANY, Catasauqua, Pa.

Branch Offices

Chicago • San Francisco • Los Angeles • Seattle • Birmingham

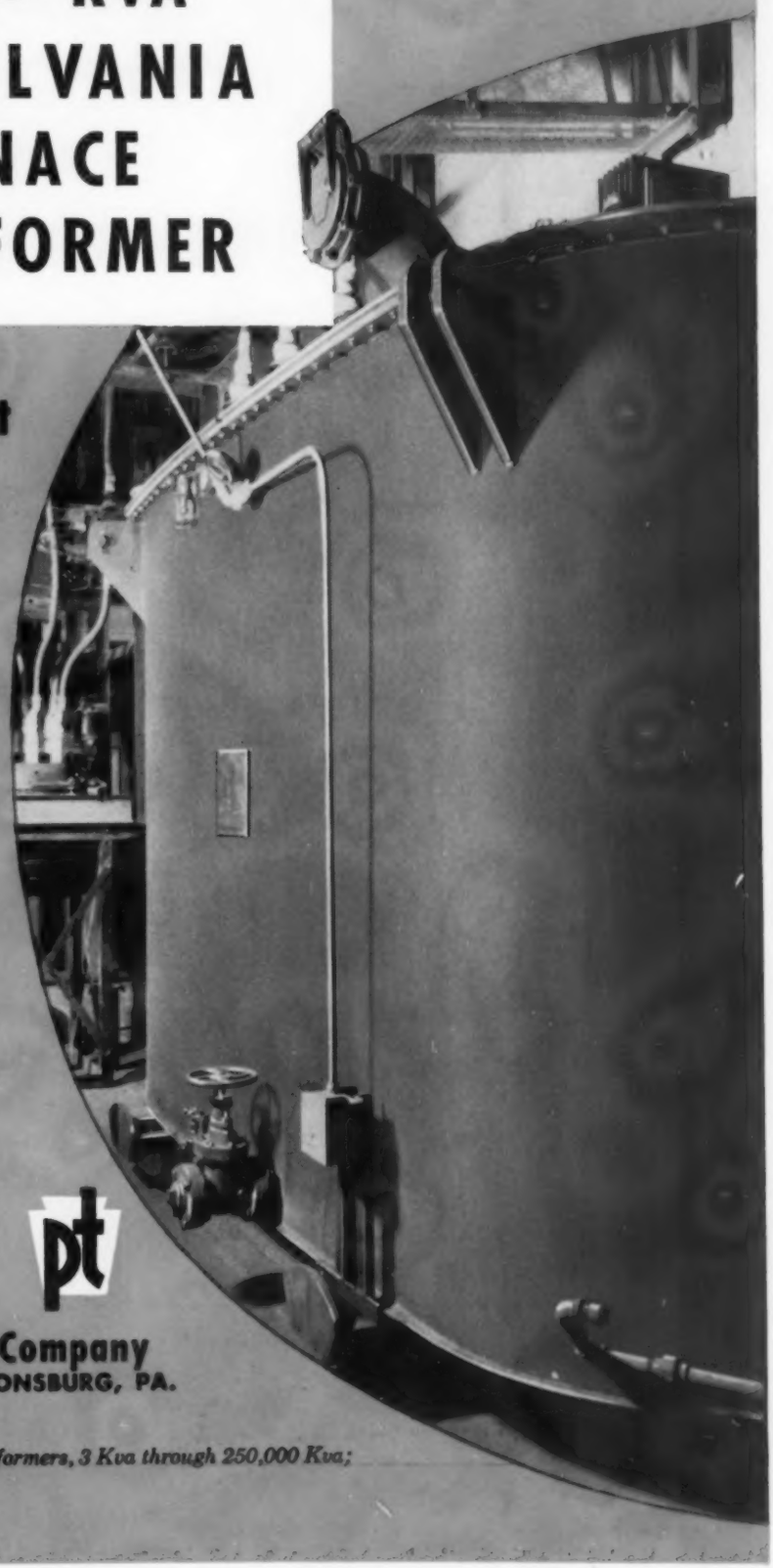
Fuller

C-237
2157

Pioneers of high-efficiency vane-type rotary compressors

New Jersey Zinc uses this

6,000 KVA PENNSYLVANIA FURNACE TRANSFORMER



at its Palmerton Plant

Pennsylvania Transformer Company has manufactured well over 1¼ million Kva of furnace transformers in ratings from 100 Kva through 25,000 Kva. The 6,000 Kva transformer at Palmerton is one of five furnace transformers purchased from Pennsylvania by New Jersey Zinc Company (of Pa.).

The successful operation of all Pennsylvania furnace transformers and their industry-wide acceptance indicate that Pennsylvania engineers fully understand the application of furnace transformers to electric furnaces.

The complicated design of a furnace transformer presents many problems that do not apply to other types of transformers. Many special conditions, such as overloads, short circuit stresses, distribution of currents, and reduction of losses must be met by engineering skill and highly perfected workmanship. Pennsylvania Transformer Company combines this engineering "know-how" and expert workmanship into each and every furnace transformer.

pt

Pennsylvania Transformer Company

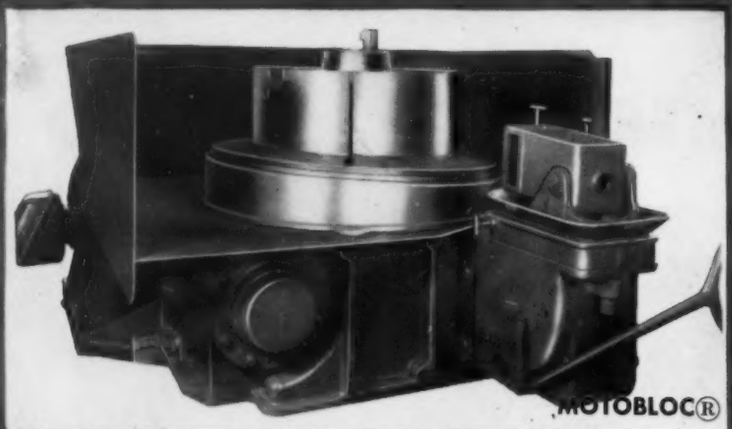
A McGraw Electric Company Division • **CANONSBURG, PA.**

Greater Pittsburgh District

Manufacturers of Power and Distribution Transformers, 3 Kva through 250,000 Kva; 480 volts through 330,000 volts.

VAUGHN

NAME IT!

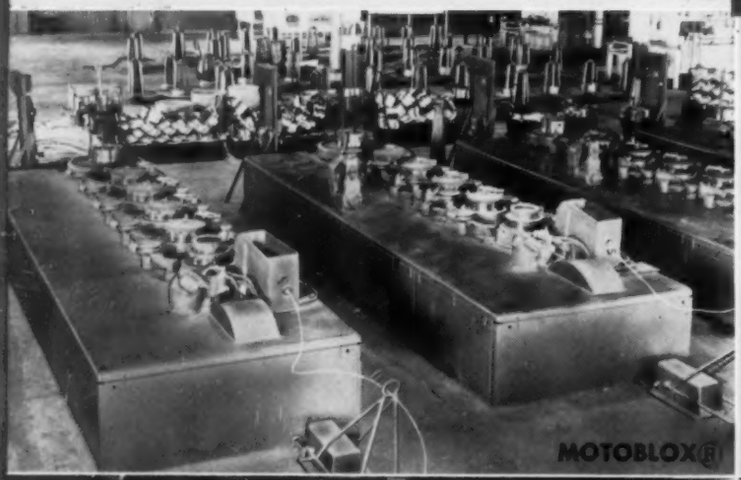


MOTOBLOC®

—you name your cold drawing requirement . . .

—let us name the profit making ***VAUGHN MACHINE*** *for your job!*

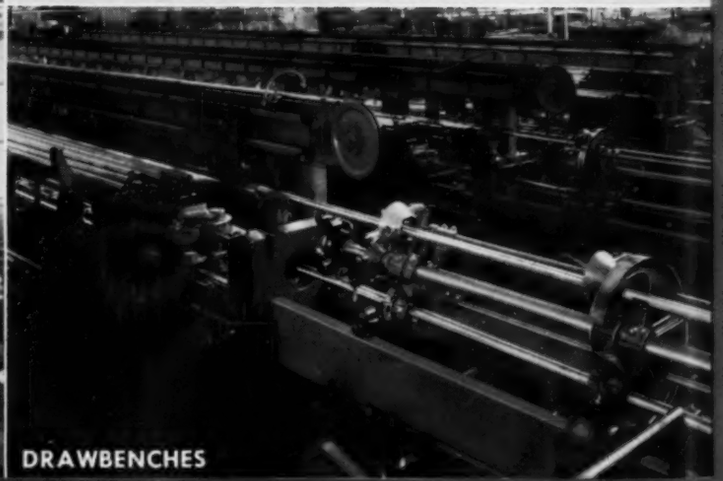
VAUGHN means *everything* in Cold Drawing Equipment—and a great deal in constructive consultation. We will be happy to translate your production requirements in terms of Vaughn machine productivity, at your convenience, and without obligation.



MOTOBLOX®

RINGBLOX®

SPECIAL PUSH-UP BLOCKS for PATENTING



DRAWBENCHES

"Quick on the Draw"

THE VAUGHN MACHINERY CO.

CUYAHOGA FALLS, OHIO, U.S.A.

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars & Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

SAFE CONTROL

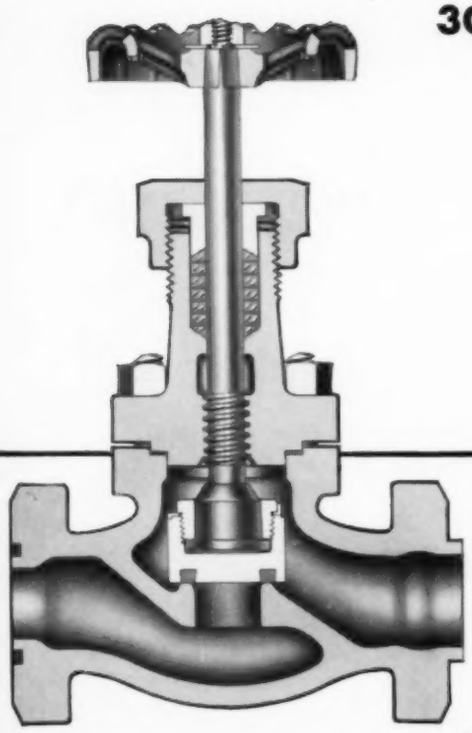
for ammonia and other hard-to-handle fluids

CRANE

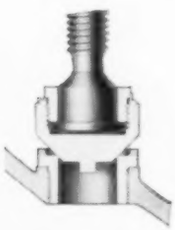
300-pound heavy-duty all-iron valves

Put these Crane valves to the test—use them for ammonia, air, oil, gas, caustic solutions, chlorinated compounds, alcohols—for chemicals and process work. Their rugged bodies of Ferrosteel (35% stronger than cast iron)... their precision seating designs... the unusually deep stuffing box and high-grade packing... the sweeping interior body contours... assure the safety and lasting service you want.

The line includes *bolted bonnet* globes and angles with choice of disc, *union bonnet* globes and angles with plug-type disc, lift checks, expansion valves, relief valves, liquid gauges—and all the fittings, flanges, return bends and other specialties for a complete Crane Quality installation. Check with your Crane man.



Cross-section bolted bonnet Globe, with flanged ends and special lead-faced disc. Sizes ¼ to 4-inch.



Bolted bonnet Globes also available with steel disc and seat where high temperatures or corrosion prohibit use of lead.

Cross-section, Lift Check with bolted cap, and cushioned disc action which increases valve life. Sizes ½ to 2-inch.

New 6-page folder AD1977 catalogs this complete Crane line. Write direct, or ask your Crane Representative.

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

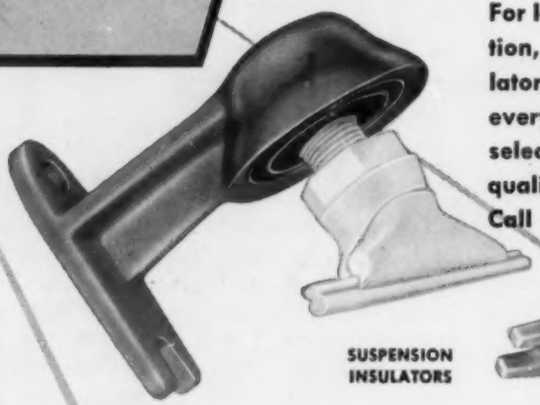
KEYSTONE INSULATORS for INDUSTRY

CONTACT RAIL
(TYPE BMS)

"SERVICE-ENGINEERED"

FOR UNFAILING PROTECTION ON THE TOUGHEST JOBS!

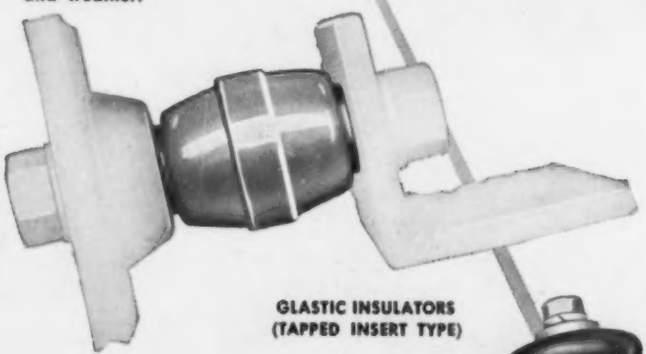
For longer, stronger life and peak protection, there's a Keystone Industrial Insulator that's "service-engineered" to meet every need. Let ESM engineers help you select the right mechanical and electrical qualities to solve your insulator problems. Call on them soon.



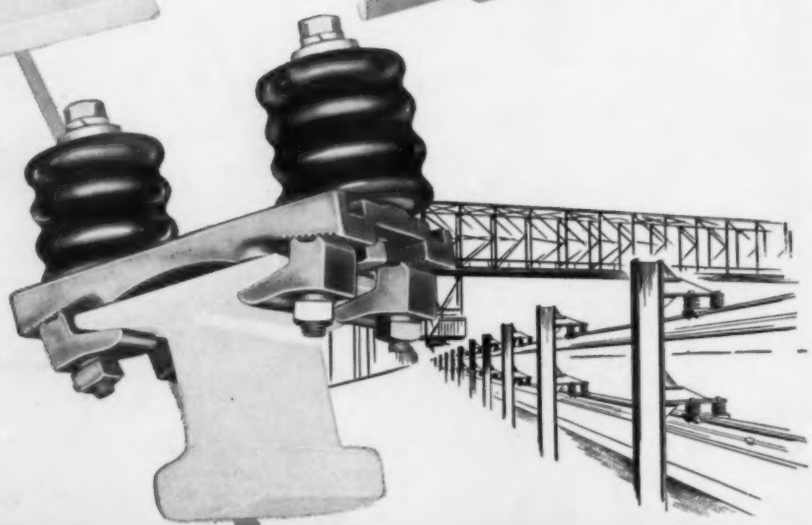
MOULDED GLASTIC INSULATORS

Fibreglass reinforcement and superior compounds provide maximum impact strength with excellent resistance to arc track, chemicals, heat and weather.

SUSPENSION INSULATORS



GLASTIC INSULATORS
(TAPPED INSERT TYPE)



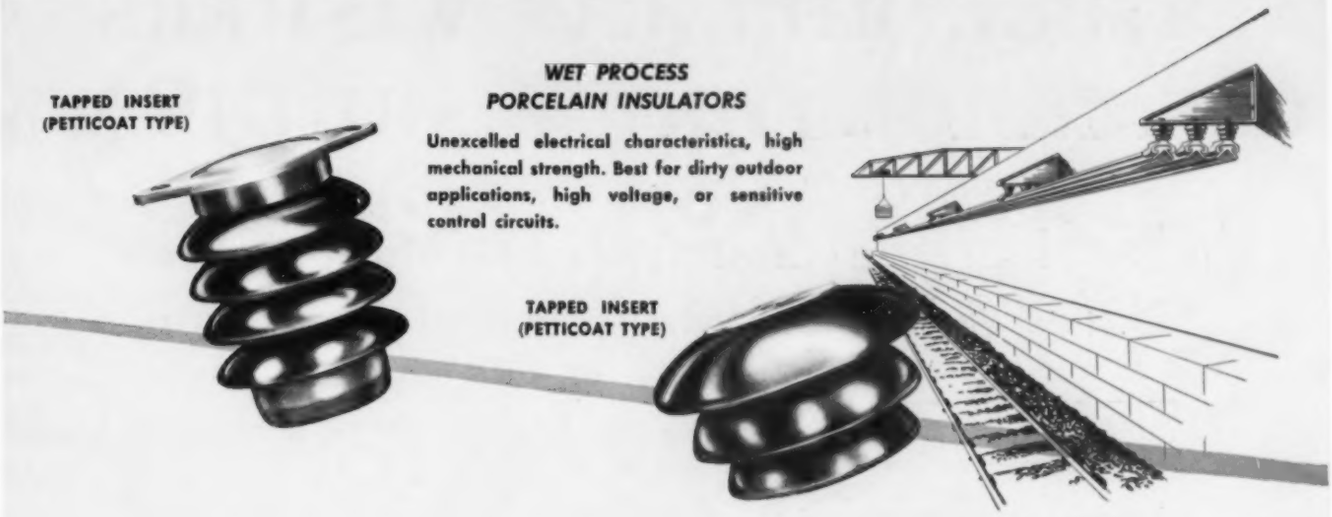
Basic units shown have great variety of application by use of proper fittings, selected from our Industrial Catalog. Write for illustrated folder.

ELECTRIC SERVICE MANUFACTURING CO.

TAPPED INSERT (PETTICOAT TYPE)

WET PROCESS PORCELAIN INSULATORS

Unexcelled electrical characteristics, high mechanical strength. Best for dirty outdoor applications, high voltage, or sensitive control circuits.

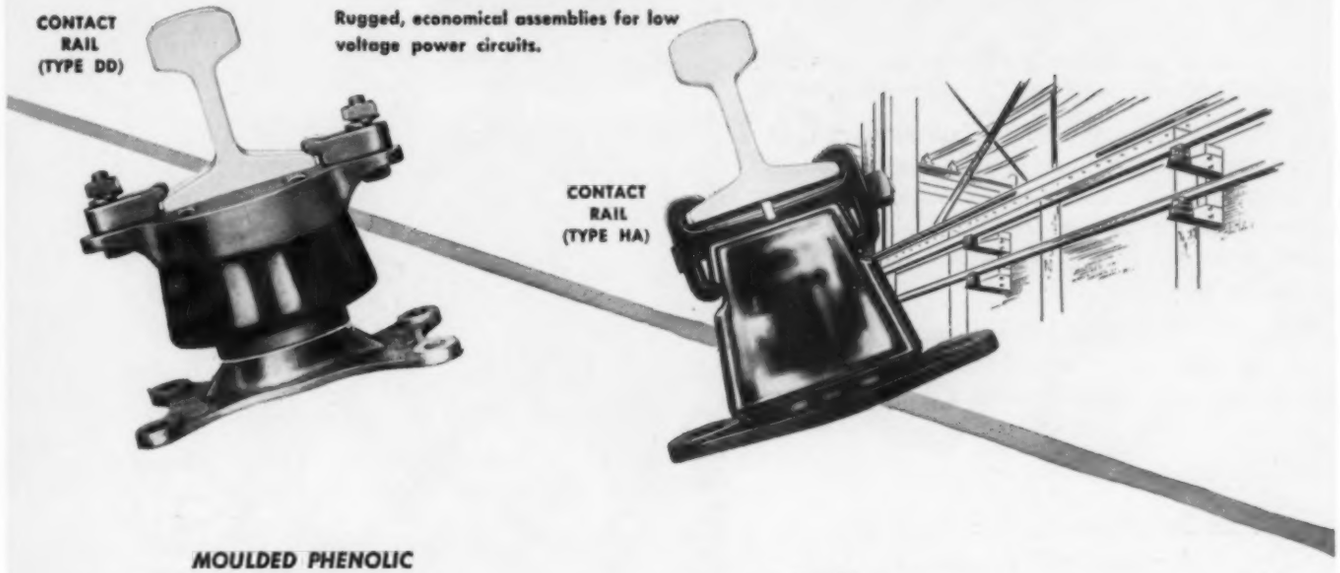


TAPPED INSERT (PETTICOAT TYPE)

DRY PROCESS PORCELAIN INSULATORS

CONTACT RAIL (TYPE DD)

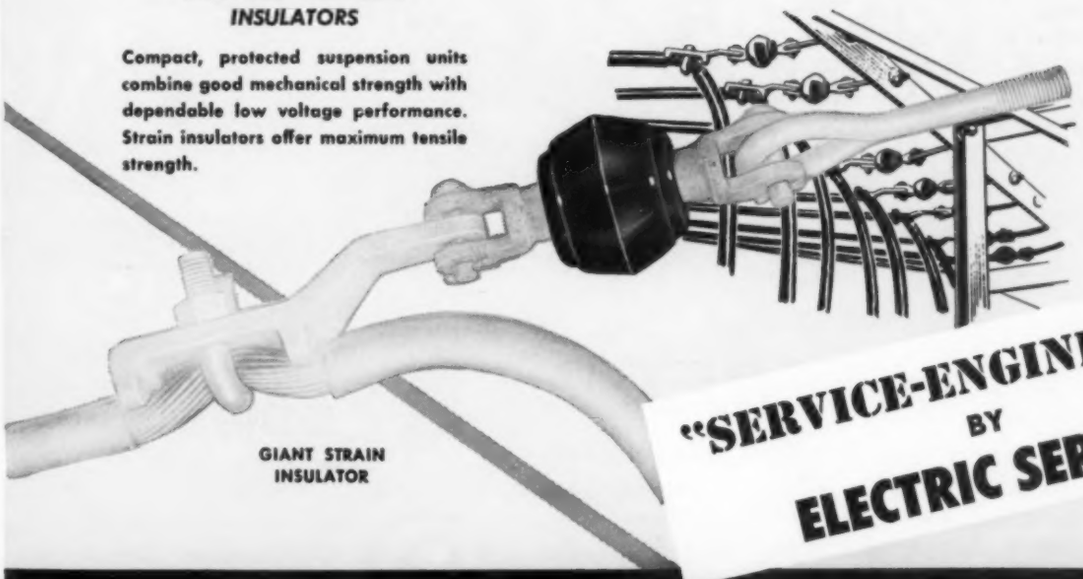
Rugged, economical assemblies for low voltage power circuits.



CONTACT RAIL (TYPE HA)

MOULDED PHENOLIC INSULATORS

Compact, protected suspension units combine good mechanical strength with dependable low voltage performance. Strain insulators offer maximum tensile strength.



GIANT STRAIN INSULATOR

"SERVICE-ENGINEERED" BY ELECTRIC SERVICE

Philadelphia 32, Pa.

Represented in Canada by Lyman Tube and Bearings, Ltd., Montreal and Toronto

STEEL MILL GAS WASHERS CLEANED WITHOUT SHUT-DOWN

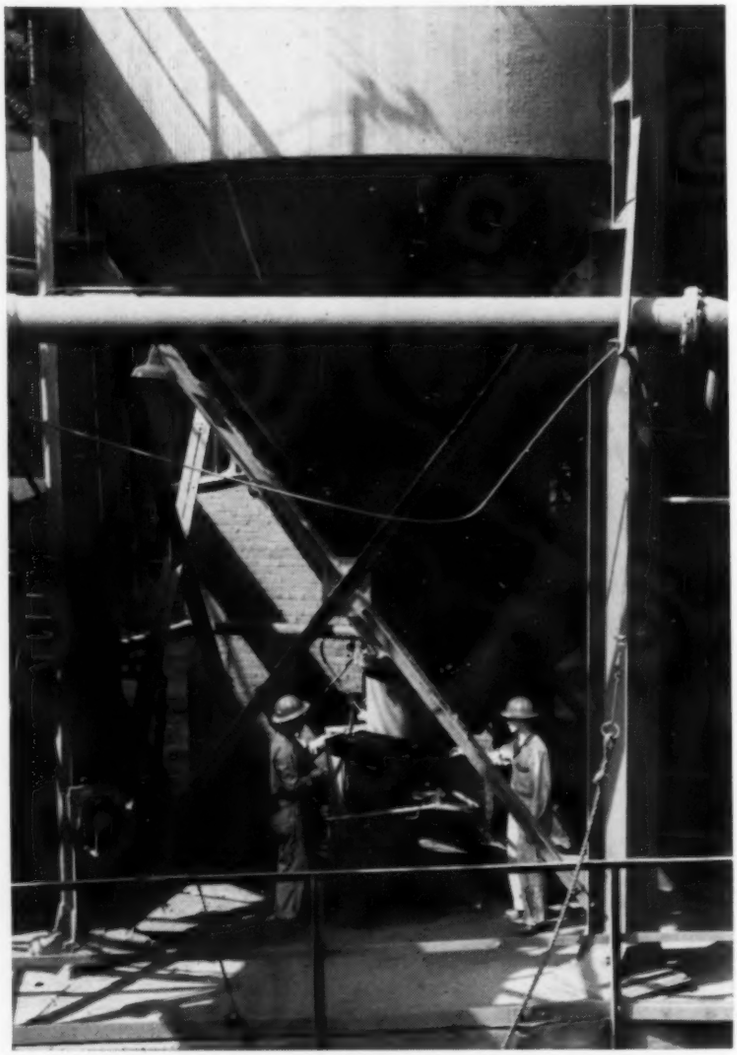
Cleaning with Chemicals by Dowell Service Saves Costly Dismantling and Downtime

Here's a comparative case history that points out the advantages of Dowell Service over mechanical cleaning methods.

The blast furnace to be serviced had three gas washers which needed cleaning. One of these was cleaned mechanically. The other two were cleaned with chemicals by Dowell Service.

The mechanical cleaning took three days time and required 768 man hours. The remaining two washers were cleaned simultaneously by Dowell Service *in just four hours* . . . without interrupting washing operations or reducing blast furnace wind.

With specially-designed Dowell pump trucks and control equipment, experienced Dowell engineers can give you fast cleaning service. Many pieces of equipment can be cleaned while in operation.



Free Bulletin on Chemical Cleaning for Steel Mill Equipment

For your convenience, we have prepared an informative bulletin that tells you about the chemical cleaning of many different kinds of steel mill equipment by Dowell Service. For your free copy, write today to Dept. A29, Tulsa, Okla.

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Chemical Services for Oil, Gas and Water Wells

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Tulsa 1, Oklahoma

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Date-line Diary...

December 1

▲ A net income of $53,219,000 for the first nine months was announced by Westinghouse Electric Corp., or $3.26 a share after taxes compared with $3.02 for the same period in 1952.

December 2

▲ Installment purchases of automobiles, appliances and other products in October were $139,000,000 as compared to $154,000,000 in September.

▲ According to secretary Wilson, the Defense Dept. will request a sum less for the next fiscal year than the $34,300,000,000 which Congress appropriated for that department during the current fiscal year.

▲ The Commerce Dept. reported U. S. exports for October rose to $1,200,000,000, up $40,000,000 from one year ago.

▲ CIO steelworkers struck the nation's two largest canmakers, American Can and Continental Can.

▲ U. S. Steel's Pittsburgh Steamship Div. completed its record breaking 1953 season with a total of 27,446,822 gross tons of ore moved down the lakes in one season.

December 3

▲ A large mill purchased large tonnages of steel scrap at $2 to $3 a ton less than it cost two weeks ago.

▲ Bethlehem Pacific shut their five open hearth furnaces at Seattle for maintenance work.

December 4

▲ The Commerce Dept. reported personal income for October rose to an annual rate of $287,000,000,000, about $1,000,000,000 above September and $10,000,000,000 over October 1952.

▲ Production of taconite will be stepped up by Erie Mining Co. who sold $207,000,000 of 4¼ per cent bonds to Bethlehem Steel Corp. and nine insurance companies.

▲ Treasury Undersecretary Folsom, announced that providing all scheduled tax reductions take effect, Government revenues will be reduced by $5,500,000,000 starting July 1, 1954.

▲ Heavy construction contract awards amounted to $294,000,000 for the week ending November 30, $149,000,000 above the preceding week, but $50,000,000 below the same week in 1952.

December 7

▲ American-owned copper mines in Chile will resume their 30,000 ton per month output. The present price of the metal there is 30¢ per lb.

▲ Construction outlays in November totaled $3,000,000,000, a drop of 6.7 per cent from October as reported by the Commerce and Labor Depts.

▲ Unemployment in November rose to 1,428,000, up 300,000 from October.

▲ U. S. Steel will cut production at its Duquesne, Pa. works by 22 per cent by December 24 when it discontinues operation of the remaining five furnaces at its old No. 1 open hearth shop.

▲ The AISI reports that operating rate of the steel industry for the week starting December 7 is scheduled at 85.8 per cent of capacity. This is equivalent to 1,934,000 tons compared with 1,972,000 tons one week ago.

December 8

▲ U. S. Steel Corp., Fairless Hills, Pa., announced a mill base price of 5.025¢ per lb for hot rolled alloy bars. Shipments of these bars will be made in limited volumes, grades and sizes.

▲ As reported by the Commerce Dept., business inventories for October dropped $350,000,000 below September, to $79,400,000,000 or $4,700,000,000 above a year ago.

▲ The board of directors of Merritt-Chapman Steel Corp. authorized negotiations to acquire Newport Steel Corp., Newport, Ky. by exchange of stock.

▲ The Aluminum Assoc. has reported total production of primary aluminum for October at 216,438,214 lb as compared with 218,666,531 lb in September, and 154,624,138 lb in October 1952.

▲ ARCI made known that deliveries of new domestic freight cars in November totaled 6137 compared with 8727 in October and 5929 in November 1952. Orders in November totaled 2680 leaving a backlog on December 1 of 31,869 cars.

December 9

▲ An expected 5,100,000,000 lb of fabricated products will be shipped by copper and brass mills in 1953, it was stated by Business and Defense Services Administration. This is a 4 per cent increase over 1952.

December 10

▲ Business expenditures for new plant and equipment will run at an annual rate of $28,000,000,000 in 1954 according to the Commerce Dept.

▲ The Commerce Dept., up to this date had licensed 93,034 net tons of iron and steel scrap for export.

▲ Delegates of 30 nations are attempting to stabilize world tin price. They hope to keep price in London between 80¢ to $1.10 per lb. Present price there is 82½¢.

December 11

▲ Factory employment in November fell to 16,700,000, off 300,000 from October, the Bureau of Labor Statistics reported.

▲ Harrisburg Steel Corp., Harrisburg, Pa. will acquire all the assets of Taylor-Wharton Iron and Steel Co., Cincinnati, Ohio.

December 14

▲ Construction awards, in the 37 states east of the Rockies, in November totaled $1,394,050,000 according to the Dodge reports.

▲ Salem-Brosius, Inc. will cut the company's outstanding shares from 9,123,775 to 364,976 in a reverse stock split.

▲ The AISI reports that operating rate of the steel industry for the week starting December 14 is scheduled at 85.0 per cent of capacity. This is equivalent to 1,917,000 tons as compared with 1,955,000 tons one week ago.

▲ The Council for Technological Advancement has announced the nation's capital goods productive activity in 1953 is expected to total $58,000,000,000. As a result, employment in these activities is expected to reach 8,200,000.

December 15

▲ The Newport Steel Corp. reports net sales for their fiscal year ending October 31 increased $13,488,000, about 27 per cent over the preceding fiscal year to $63,990,000. Net income was $2.06 a share.

▲ Electricity generated by utilities in 1953 is expected to hit a new high of 441,500,000,000 kwhr or a 10.6 per cent gain over 1952.

December 16

▲ Secretary of Defense Dept. Wilson, ordered the military to discontinue processing iron and steel scrap, and stop business activities which can be performed by private companies.

▲ Transportation along the Great Lakes hit a record 164,000,000 tons of iron ore, coal and grain in the season to December 1. This was a 25 per cent gain over the 1952 total and a gain of 6.4 per cent over the previous high in 1942.

▲ Republic Steel Corp., Cleveland, Ohio will halt operations over the holiday period for 12 days to make repairs to its blooming mill.

▲ General Electric Co. and Westinghouse Electric Corp. expect 1954 electrical equipment and appliance sales to be on the same level with 1953.

December 18

▲ U. S. Steel Corp. idled a number of furnaces to curtail production because of a year-end drop in orders.

December 21

▲ The Commerce Dept. estimates a total of $11,700,000,000 was spent in 1953 on residential construction.

▲ The AISI reports that operating rate of the steel industry for the week starting December 21 is scheduled at 66.6 per cent of capacity. This is equivalent to 1,502,000 tons as compared with 1,900,000 tons one week ago.

December 22

▲ An estimate by Foreign Operations Administration indicates foreign aid spending in the fiscal year ending June 30, 1954 will be between $5,000,000,000 and $6,000,000,000.

▲ A prediction of Melvin H. Baker, chairman of National Gypsum Co., is that construction contracts in 1954 will amount to about $34,000,000,000, being the second best year in history.

▲ U. S. Steel Corp. announced an increase in mill price base for silicon steel sheet of approximately 3 per cent.

December 23

▲ Steel scrap prices declined further in the Youngstown district with a drop of $1 to $2 a ton.

▲ The Lake Superior Iron Ore Exchange reported iron ore consumption in November fell to 7,521,886 gross tons, about 10 per cent below the 8,131,437 tons consumed in October.

December 24

▲ Electricity consumption for the week ending December 19 was the highest in history with a figure of 8,900,000,000 kwhr, an increase of 7.4 per cent for the same period in 1952.

▲ The value of new autos, trucks and buses produced and sold in 1953 is estimated at $11,400,000,000 by L. L. Colbert, president of Chrysler Corp.

▲ Republic Steel Corp. has signed an exploratory option for iron ore properties near Lima, Peru. Land covers about 62,500 acres.

December 28

▲ Sawhill Manufacturing Co., Wheatland, Pa., Mercer Tube and Manufacturing Co., Sharon, Pa., and Shenango Agaloy Tube Co., Sharon, Pa. will combine into a corporation under the name of Sawhill Tubular Products, Inc.

▲ The AISI reports that operating rate of the steel industry for the week starting December 28 is scheduled at 74.3 per cent of capacity. This is equivalent to 1,674,000 tons as compared to 1,444,000 tons one week ago. Steel production index for week is 104.1.

▲ According to the AISC, November shipments of fabricated structural steel amounted to 257,489 tons, a decrease when compared to the 295,459 tons in October, but an increase of 15 per cent over November 1952. Orders for November totaled 151,498 tons leaving a backlog on November 30 at 1,804,079 tons.

December 29

▲ Chrysler Corp. completed the $35,000,000 purchase of the principal automotive plants of the Briggs Manufacturing Co. thus acquiring ownership of the body building facilities for entire output of Plymouth cars. Chrysler already builds bodies for Dodge, DeSoto and Chrysler automobiles.

December 30

▲ Republic Steel Corp. recalled 4500 idled workers and will resume full operations at its Cleveland plant.

▲ A report of the American Institute of Steel Construction indicates shipments of fabricated structural steel are expected to be less in 1954 than in 1953. Early reports show total shipments for 1953 were 3,100,000 tons which is 436,000 tons greater than the total for 1952.

December 31

▲ Allegheny Ludlum Steel Corp. reduced prices on some types of stainless steel bars, plates, sheets, cold rolled strip and forgings by $5 to $30 a ton.

▲ Effective January 1, Inland Steel Co. will have an annual production capacity of 4,700,000 tons. There was an increase of 200,000 tons during 1953.

25 ton Bedford Magnet Crane with 90 ft. span over Blooming Mill Slab Yard in new mill recently constructed by Detroit Steel Co. at New Boston (Portsmouth), Ohio.

Another Bedford Crane for Detroit Steel

Proof of the superiority of Bedford Cranes is found in the high percentage of *repeat orders* from important owners through the years.

In steel mills, power plants, and throughout industry . . . wherever superior performance is *expected*, owners enthusiastically recommend Bedford Cranes.

Available in all types and sizes . . . from five tons to 350 tons and up . . . for all kinds of indoor and outdoor services . . . each Bedford Crane is individually engineered and precision built for its specific application.

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(Write for complete catalog describing Bedford Cranes in detail.)

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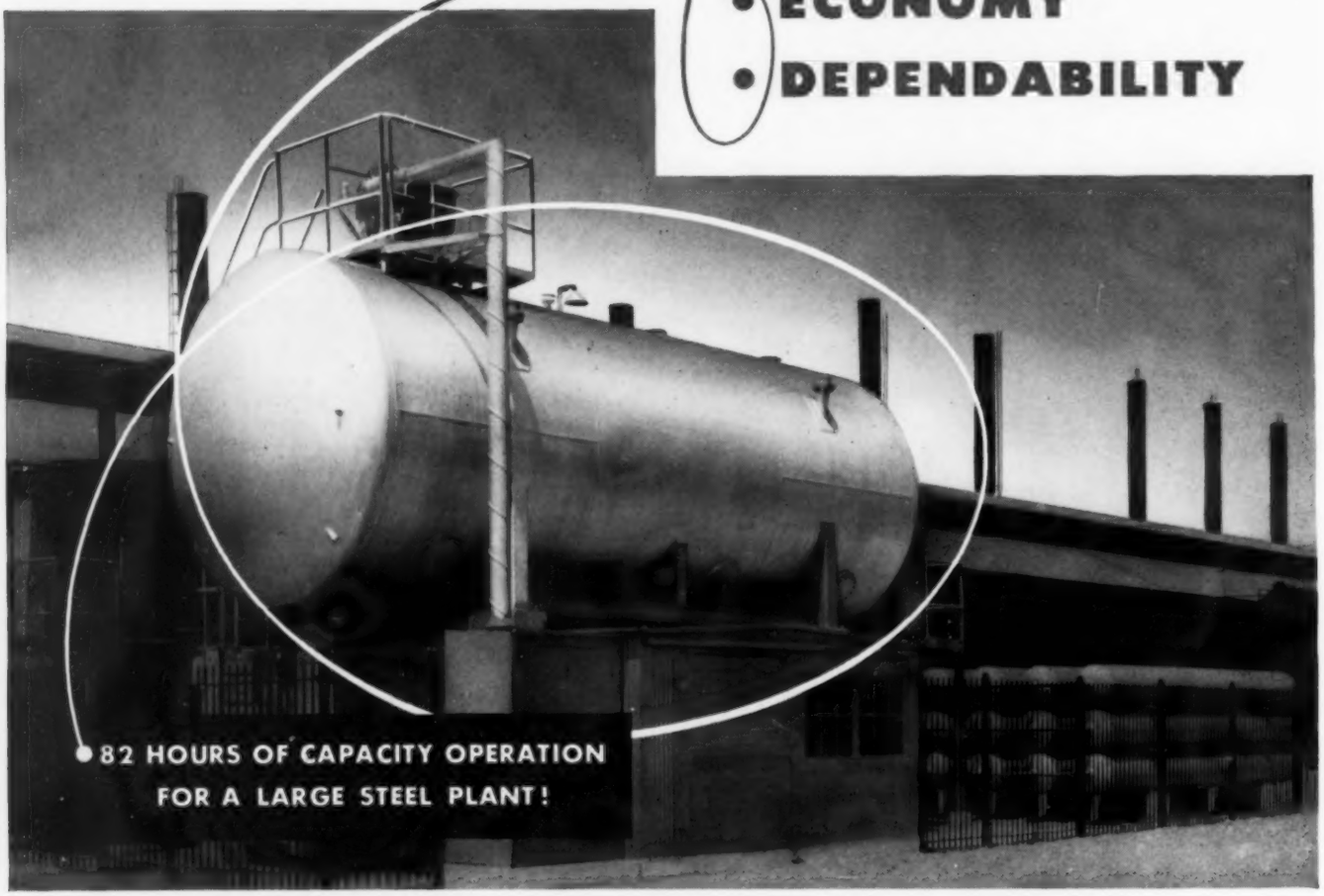
Why LINDE OXYGEN ... plus LINDE SERVICE*

are your assurance of

- EFFICIENCY
- ECONOMY
- DEPENDABILITY



DRIOX liquid oxygen storage units such as this hold as much as 12,250 oxygen cylinders—enough for 82 hours of capacity operation of a large steel plant.

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LINDE's many plants are strategically located to assure dependable supply to meet every need. There can be no oxygen shortage or delay due to failure of a single plant.

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Widest choice . . . *for engineered instrumentation*

EACH of the thousands of industrial processes presents its own peculiar problems of measurement and control. Naturally, no single instrument can solve all of these varied problems. Serious compromises would have to be made in performance, convenience, and cost.

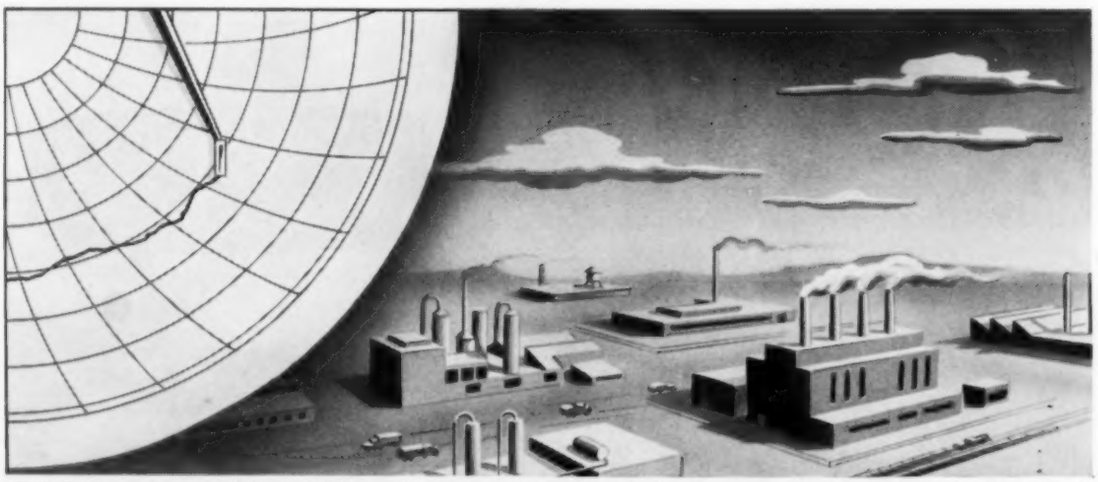
The many Honeywell primary elements, instruments, control systems, and final control elements constitute a uniquely complete family, covering practically the whole spectrum of industrial measurement and control. You can be sure that the combination selected for your job is recommended without bias, and with full consideration for every need of the application.

Included are *ElectroniK* instruments for indicating, recording and controlling a host of variables, in circular and strip chart models; *Tel-O-Set* miniature indicators, recorders and controllers; *Pyr-O-Vane* millivoltmeter controllers; square root and linear flow meters; thermometers; pressure gauges. Electric and pneumatic control systems range from the simplest to the most complex, including fully automatic program control. Primary elements include thermocouples, thermometer bulbs, *Radiamatic* elements, pH assemblies, conductivity cells, flow meter bodies and many others. For final control elements, there is a full range of motorized and diaphragm operated valves. Supplementing these are more than 7000 different non-indicating devices for controlling temperature, pressure, vacuum and other conditions.

"Building block" approach

These are the building blocks of measurement and control. To combine them into systems custom-fitted to your process, Honeywell offers the know-how gained through years of experience in all branches of industry. Whether your process calls for a single instrument or a complete central control panel, you can be sure of getting the peak in performance and value . . . and the advantages of a single responsibility for the entire installation . . . when you specify *engineered instrumentation by Honeywell.*

Efficiency-*coordinates*



COMPLETE COVERAGE *of industrial requirements for instrumentation is at your command in the Honeywell line. Whatever you need to measure or control . . . to any accuracy . . . with any of a variety of special features . . . you'll find Honeywell instruments offer the most efficient solution.*

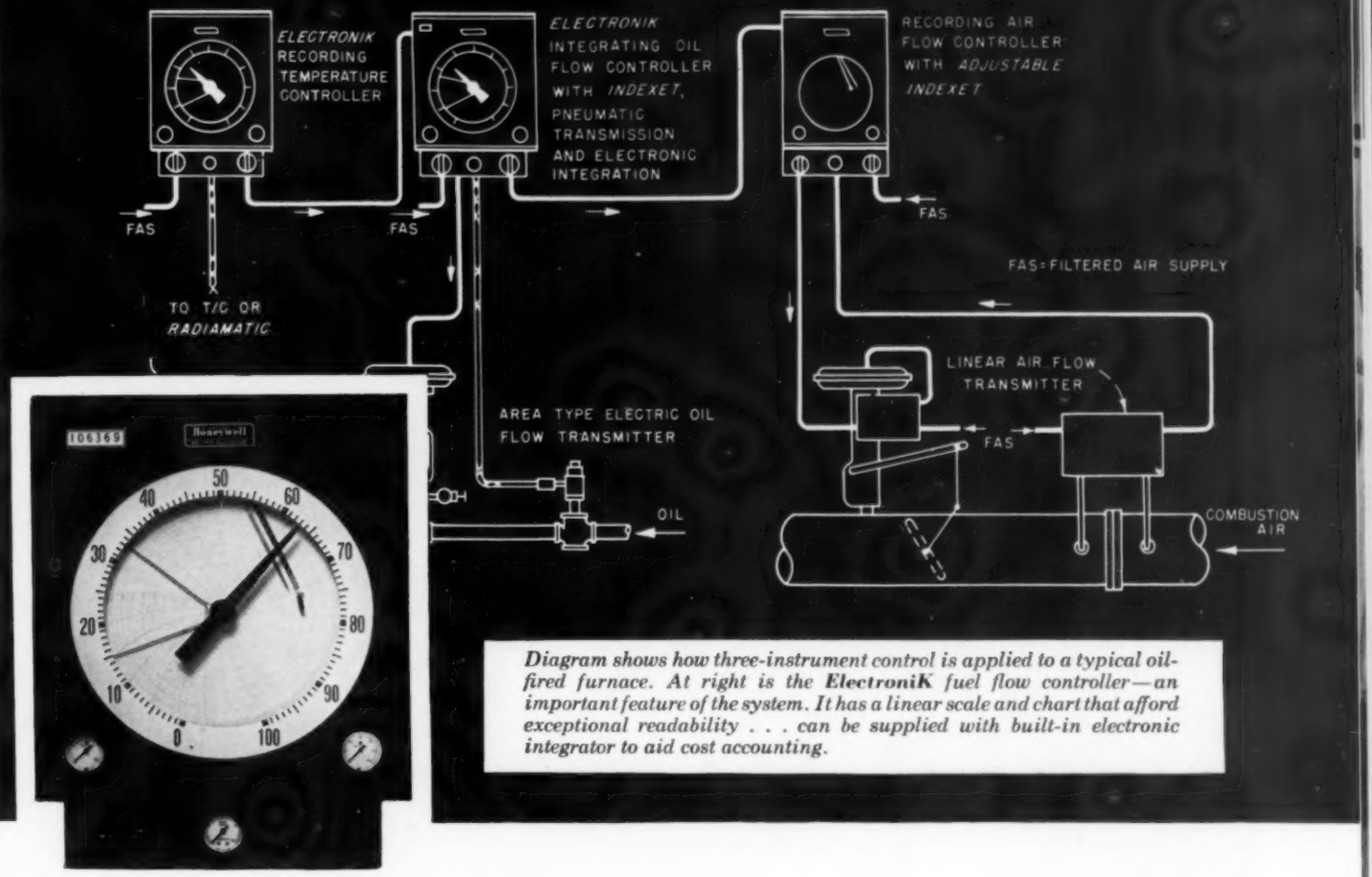


Diagram shows how three-instrument control is applied to a typical oil-fired furnace. At right is the ***ElectroniK*** *fuel flow controller—an important feature of the system. It has a linear scale and chart that afford exceptional readability . . . can be supplied with built-in electronic integrator to aid cost accounting.*

boosting furnace control *temperature, fuel and air*

FUEL-FIRED FURNACES and kilns operate at higher efficiency, and with constant atmosphere . . . when they're regulated by Honeywell Fuel-Air Ratio control. This coordinated system interlocks temperature, fuel flow and air flow . . . keeps air and fuel in constant step with each other . . . proportions both to every change in heat demand.

This three-instrument system is applicable to any fuel-fired furnace. An *ElectroniK* temperature controller resets an *ElectroniK* fuel flow controller . . . which meters fuel, regulates the fuel valve, and, in turn, resets an air flow controller which adjusts combustion air in the desired proportion to fuel.

Outstandingly stable, the system responds quickly, but without cycling. Fuel-air ratio can be adjusted readily to any desired value, and can be biased to compensate for air infiltration or to change ratio at low flows. On dual fuel furnaces, a single switch transfers measurement and control from one fuel to the other.

Call in our local engineering representative for a discussion of your own furnace requirements . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Data Sheet No. 4.3-4a, "Metered Fuel-Air Ratio Control."**

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

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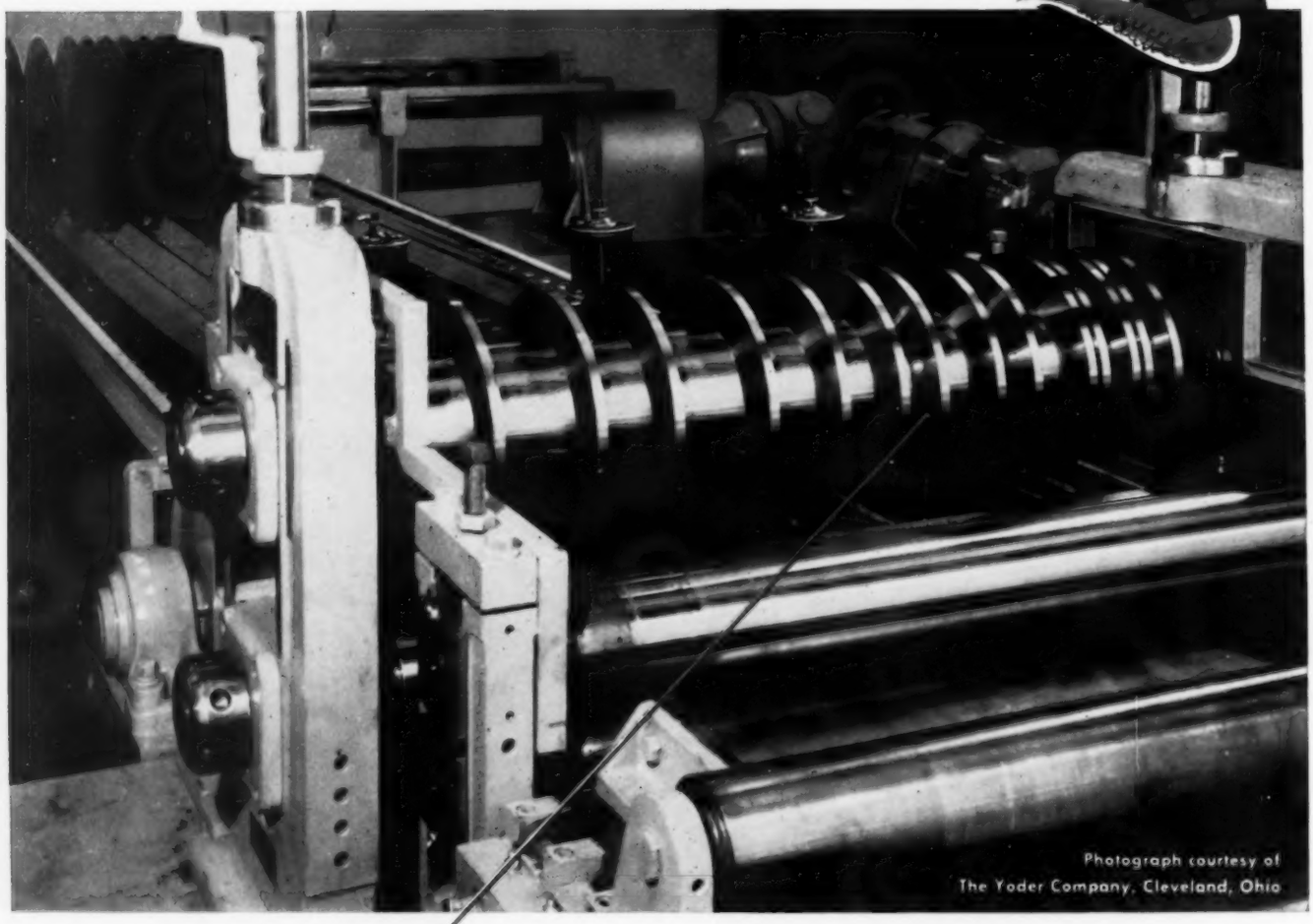
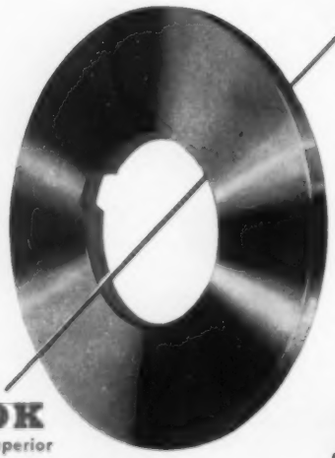


Photograph courtesy of
The Yoder Company, Cleveland, Ohio

Watch costs drop with OK slitters



OK superior performance can cut your cost, speed your production.

. . . because OK Slitter Knives run hour after hour without re-grinding, giving you top machine productivity at all times. Here's why: exact metallurgical specifications for our steel—an exclusive heat treating process to give uniform hardness and temper—special grinding and finishing to tolerances of ± .00025 or finer.

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World's largest exclusive manufacturers of knives

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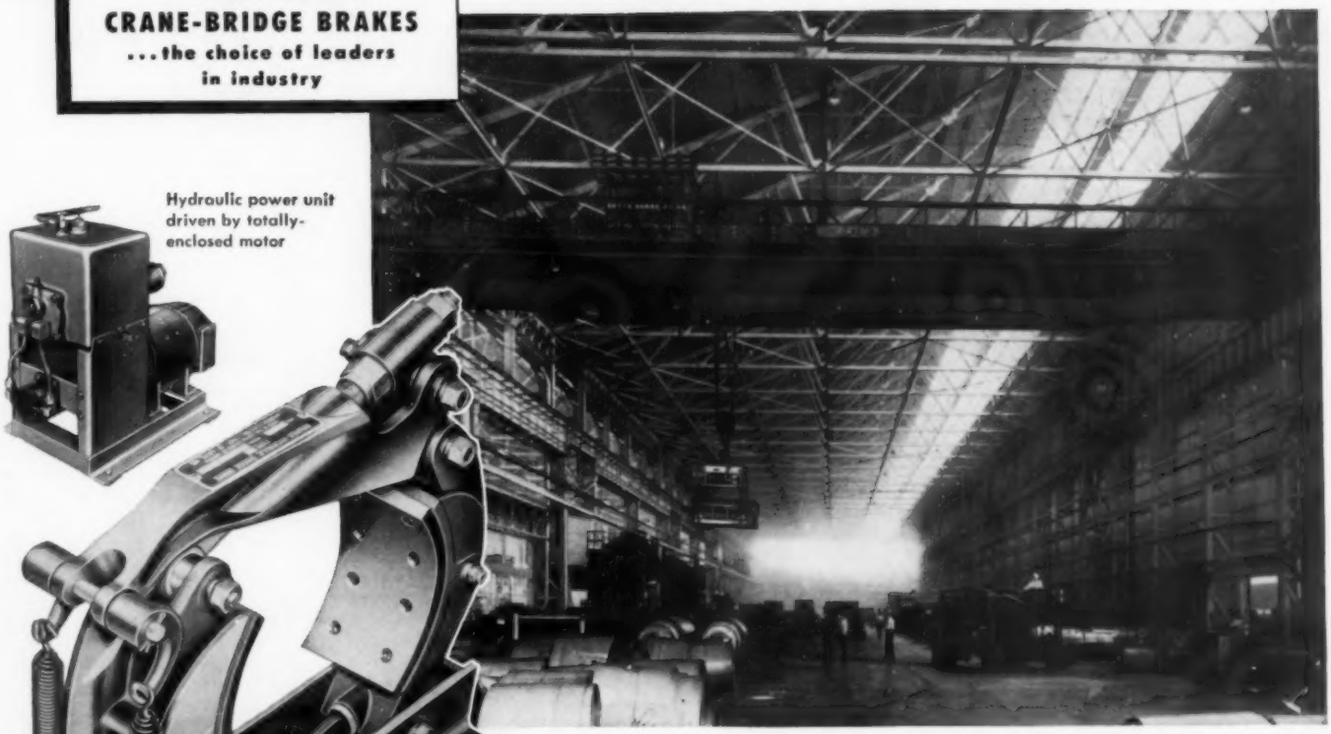

Hydraulic power unit driven by totally-enclosed motor

Type H or HM2 Brake Unit

Wagner *POWERED*

Hydraulic Crane Bridge Brakes

stop tons of weight at the touch of a toe

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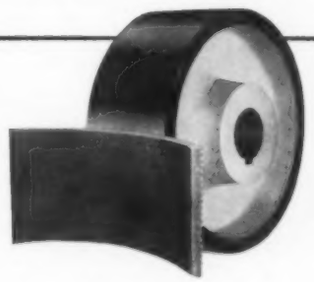
Wagner Powered Hydraulic Braking Systems are designed for applications where frequent starts and stops are necessary... where close spotting is used... where large heavy equipment is involved... and for applications where exceptional ease of brake operation is desired.

Wagner Powered Braking Systems reduce the operator's tendency to drag brakes and wear out wheels and linings quickly.... One customer reports sufficient savings on brake relining costs to pay for the power unit in less than two years! These systems mean longer life for your equipment—cranes can be controlled without plugging the bridge motor and damaging the motor and gears.

Wagner Powered units can be added to your present Wagner Hydraulic Bridge Brake System. Delivery is quick—only eight weeks are required for the average order. Investigate this new method of braking today—write for Bulletin IU-36 which fully explains and describes Wagner Powered Hydraulic Braking.



Replacement Lining and Brake Wheels

Wagner offers the perfect combination of brake wheel and non-scoring lining for replacement needs. Wagner Brake Lining is especially designed and manufactured to meet the exacting service requirements of industrial braking. It is available in rolls, blocks and discs. Section 6 of Catalog IU-40 gives complete information.

Wagner Electric Corporation EST. 1891

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TIMKEN® bearings on plate mill average 4,330,000 tons rolled—exceed tonnage expectancy by 64%

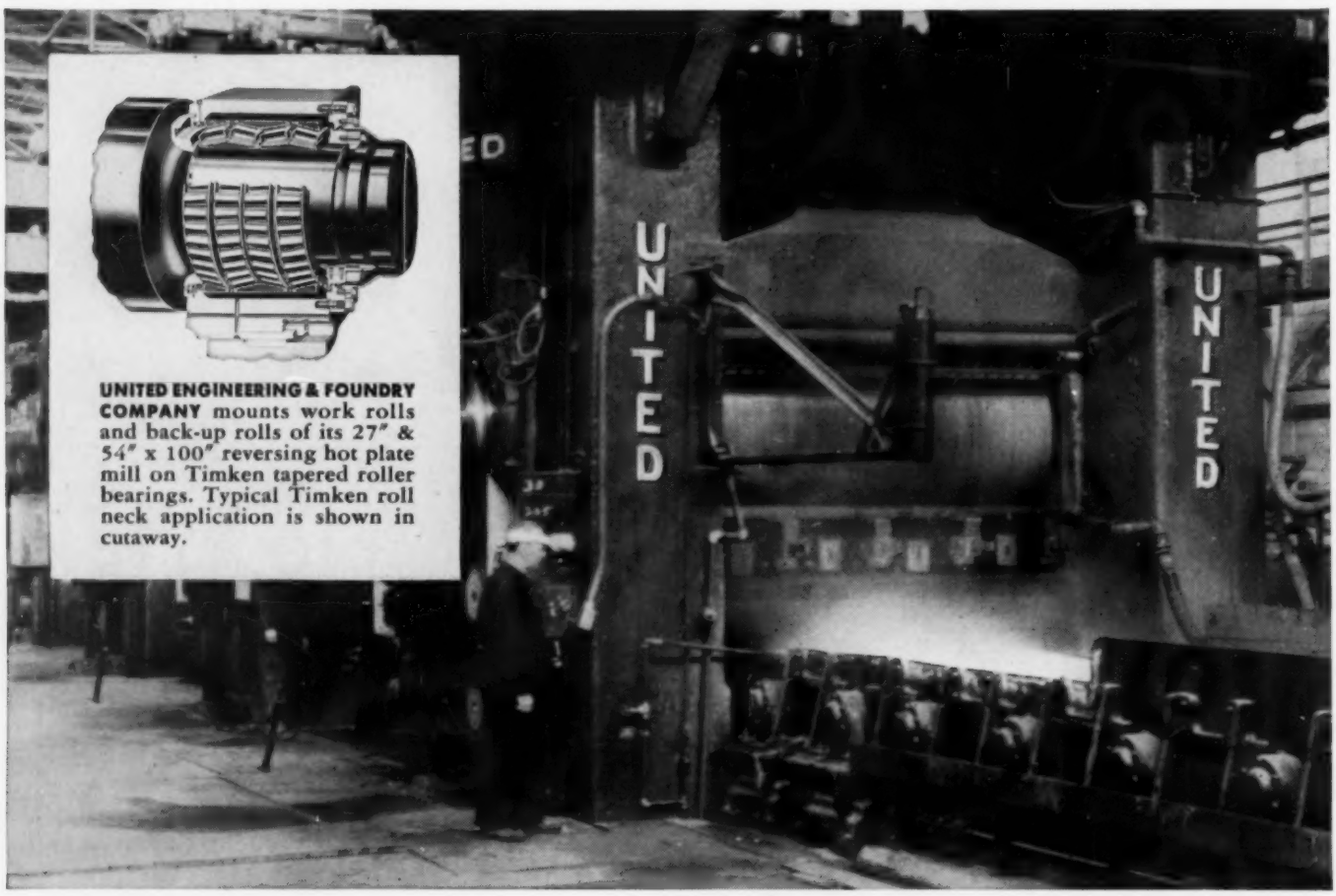
THE original back-up roll bearings, 31″ I.D., 38″ O.D. and 33″ wide, purchased by United Engineering & Foundry Company in 1936 for a semi-continuous plate mill 27″ & 54″ x 100″, have rolled an average tonnage of 4,330,000. Some of these bearings have rolled between 8,000,000 and 8,250,000 tons.

Why have Timken® tapered roller bearings compiled this amazing record? Because: (1) they were engineered for the job, (2) they were precision manufactured, (3) their true rolling motion, made possible by the tapered design and smooth surface finish, practically eliminates friction.

No special thrust bearings are needed with Timken bearings. Their tapered construction takes radial, thrust and combination loads. Chuck mountings are simpler and more compact. Weight is minimized.

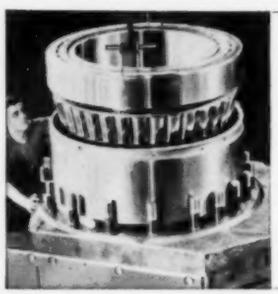
Per ton of steel rolled, Timken bearings cost less to operate than any other bearings. Actual tonnage records prove this fact. Be sure to specify Timken bearings for all the rolling mill equipment you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



UNITED ENGINEERING & FOUNDRY COMPANY mounts work rolls and back-up rolls of its 27″ & 54″ x 100″ reversing hot plate mill on Timken tapered roller bearings. Typical Timken roll neck application is shown in cutaway.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



ROLL NECK BEARING ENGINEERING SERVICE

Our field and service engineers have had years of experience with problems of roll neck bearing design and operation. They'll help you select bearings and design mountings. The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

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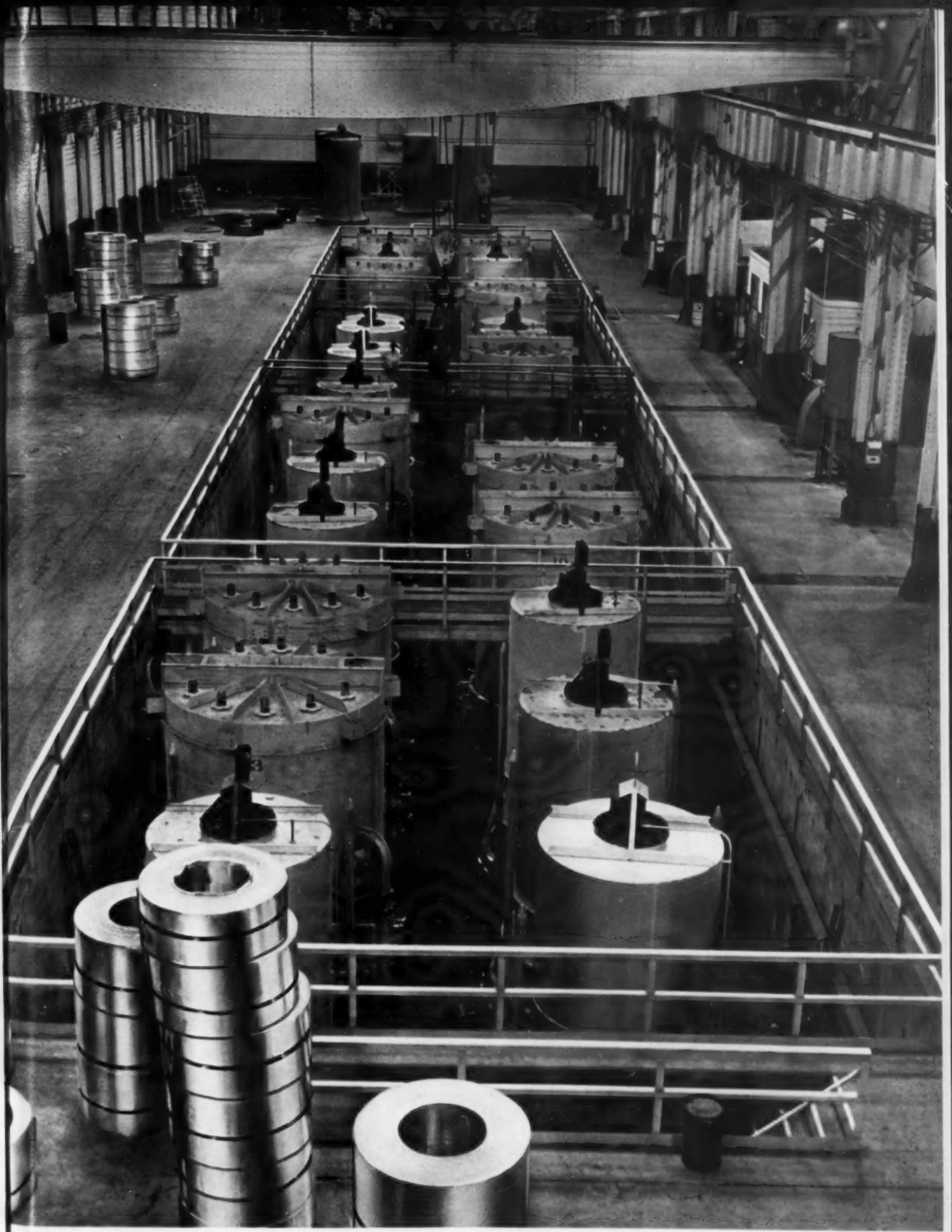
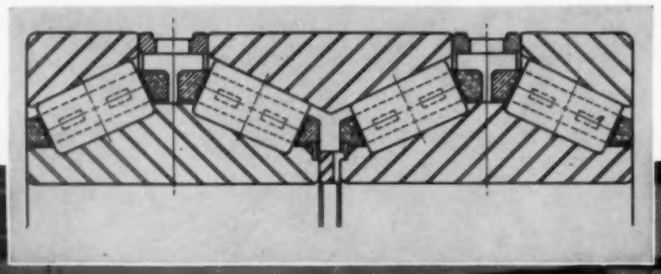


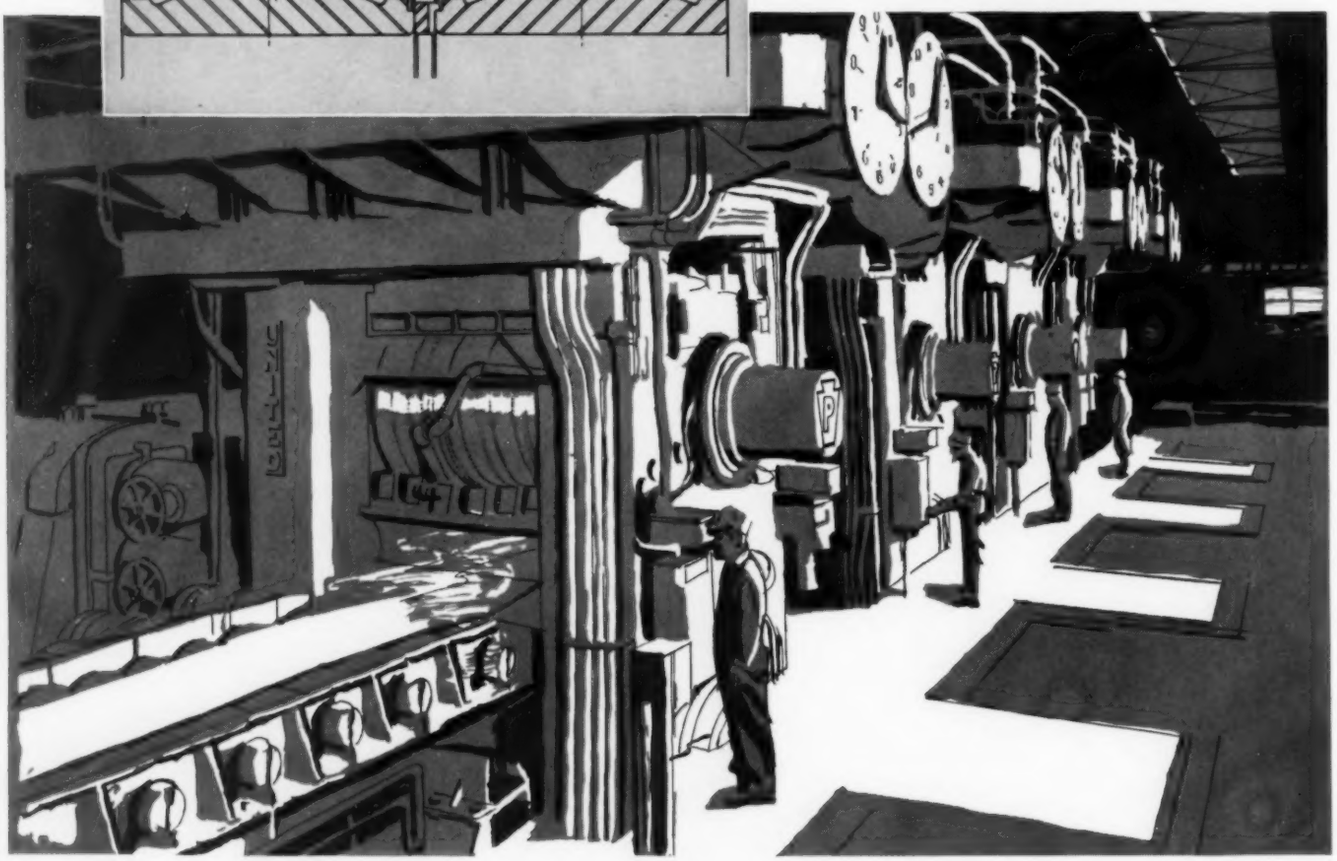
The Lee Wilson annealing installation at Detroit Steel Corporation, Portsmouth, Ohio

LEE WILSON ENGINEERING COMPANY, INC.

20005 West Lake Road Cleveland 16, Ohio



Precision ground TORRINGTON Four-Row Tapered Roller Bearings on work rolls help speed production of Pittsburgh Steel's new 66-in. United hot strip mill, one of the fastest rolling mills of its type, at Allenport, Pa.



Speeding production in modern strip mills!

With rolling speeds and loads constantly increasing, more and more modern strip mills are equipped with TORRINGTON Bearings.

These rugged, precision-ground bearings are designed for today's toughest roll neck applications. Their precision tolerances and finishes cut friction to a minimum. Their stabilized races assure uniform load distribution. Built from the finest of electro-furnace alloy steels—carefully heat treated by the most advanced methods—they give maximum load bearing capacity, longer service life.

TORRINGTON Bearings are available in a variety of types—including cylindrical, tapered and spherical roller—capable of handling any combination of thrust and radial loads.

Specify TORRINGTON Bearings for your own rolling mills.

THE TORRINGTON COMPANY
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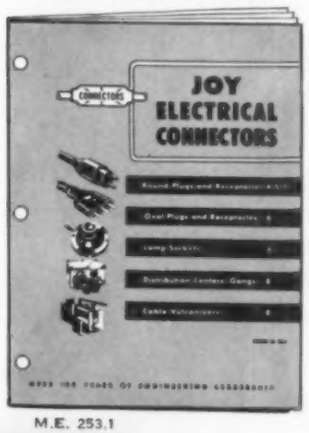
Safety is no accident

When JOY *electrical connectors are on the job*

In Industry . . . metallic dust, grime, moisture and careless handling are dangerous enemies of electrical connector performance. Constantly present around most installations they quickly try to increase resistance, crack insulation, fray wiring and corrode contacts, thereby shortening the life span and reducing the safety of electrical connectors. Fortunately, JOY plugs and receptacles are little affected by these conditions. Vulcanized to their cable as one-piece molded Neoprene units, they can't crack . . . won't lose shape . . . and require no special consideration to insure a long life of safe, efficient service. Hundreds of styles and sizes are now available for Industrial needs. So *for safety's sake* remember JOY when you next need electrical connectors . . . and in the meantime ask for your free copy of Bulletin MC108. It provides valuable additional information on Industry's favorite plugs and receptacles.

BULLETIN MC108



M.E. 253.1

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Denso Iron Rolls
Nickel Grain Rolls
Special Iron Rolls
Nioloy Rolls
Flintuff Rolls
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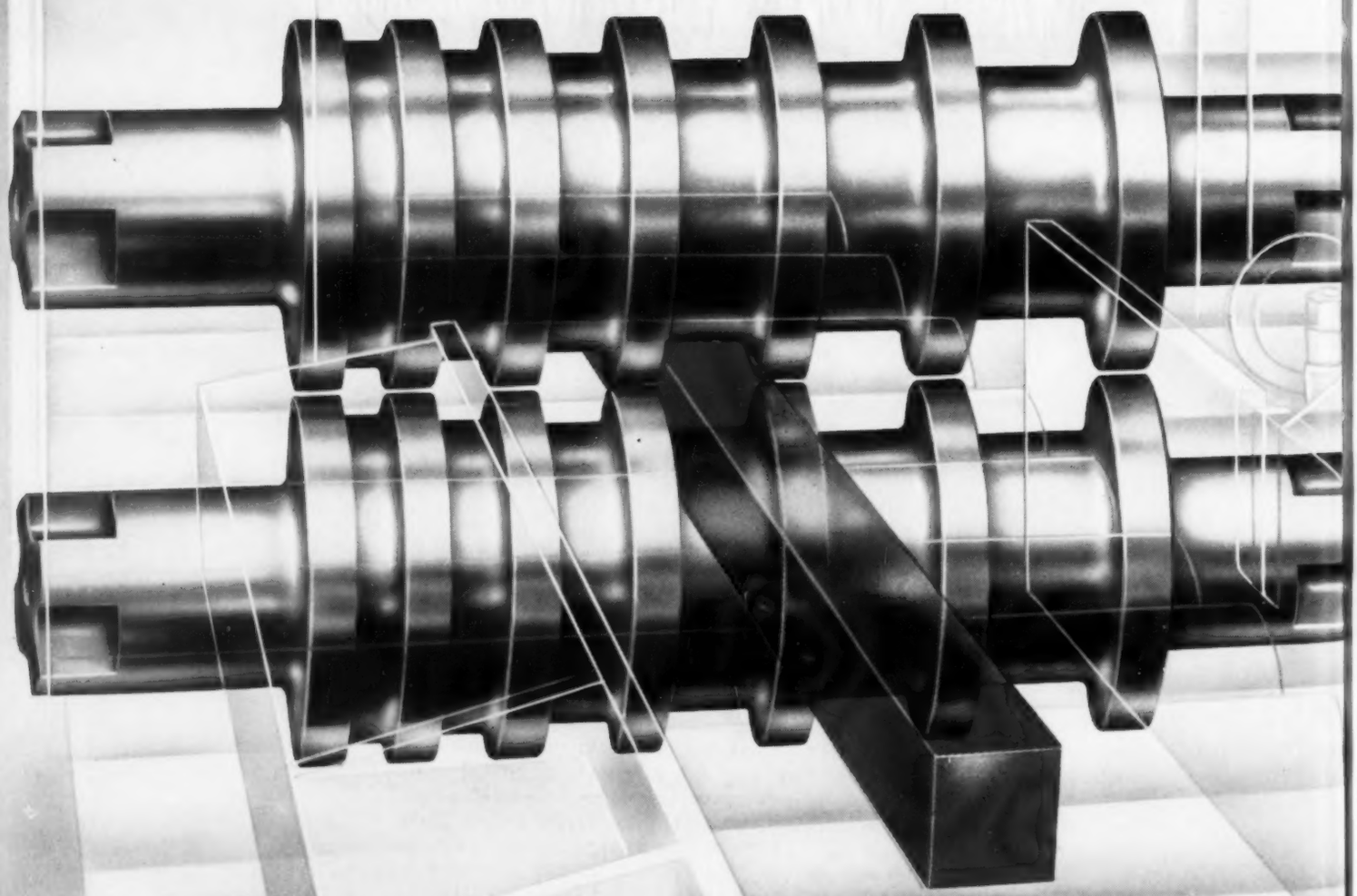


THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • PLANTS AT LIMA AND SPRINGFIELD, OHIO

Industry News...

INLAND STEEL SET 79 ANNUAL RECORDS AT INDIANA HARBOR WORKS DURING 1953

▲ Indiana Harbor Works of Inland Steel Co. set 79 annual records to make 1953 the biggest production year in the plant's 51 years of operation.

Production in 1953 totaled 4,513,021 tons of steel ingots, 15 per cent above the previous record set in 1951, announced Joseph L. Block, president. This tonnage was more than the annual output for the seven years from 1913 through 1919.

The year-around production effort also saw notched up 164 monthly records, 65 weekly records, 137 daily records and 200 turn records, Mr. Block said, climaxed by 33 production and rolling records set during December, including an all time ingot production record of 404,494 net tons.

A high operating rate of 100.29 per cent of rated capacity indicated the capacity operations during the year. Inland announced that an expansion program in its open hearth shops would push 1954 rated annual capacity to 4,700,000 ingot tons, an increase of 200,000 tons.

The year also marked the first full operation of Inland's new four-furnace No. 3 open hearth shop, Mr. Block noted.

Total plant shipments soared to a new yearly high of 3,593,040 net tons, 98,400 tons more than shipped in the record 1951 year.

New records were put on the books by blast furnace, coke ovens, the blooming mills, hot and cold strip mills, cold strip picklers, tin mills, 10-in. mill, the continuous galvanizing plant and the power and steam departments as well as the open hearths, Block reported.

Highlights of the year's operations were: the blast furnaces set an eight-furnace combined record of 2,799,100 tons, bettering a previous high of 2,671,266 tons in 1951.

Coke plants set seven combined records and made a record high tonnage of 2,173,378, compared with the previous record 2,103,754 set nine years ago.

In setting the yearly ingot production record, the open hearths set 6 monthly, 14 weekly and 10 daily marks.

The Harbor Works three blooming mills rolled a total of 4,477,360 equivalent ingot tons, topping the 1951 record of 4,190,590 equivalent ingot tons. The two hot strip mills, the 76-in. and 44-in., marked up a combined record of 2,534,755 net tons, up 235,231 net tons from the 1950 high.

Twenty-four new annual records were set by the cold strip mill in shipping 1,003,809 net tons. The tin mill and galvanize departments set a total of eight new annual records.

Record production helped push employment to an all-time high, with more than 18,500 employees on the payroll at year's end.

Peak performances also were set by plant service departments, with the operating service and engineering departments sharing in the record 23-day changeover of the 40-in. bloomer to a 46-in. capacity.

Service departments operated at high levels to keep operations at a peak, as indicated by the 297 billion gallons of water used and returned to Lake Michigan, and the generation of 813,087,000 kw hours of electricity, all of the power requirements of the Indiana Harbor Works.

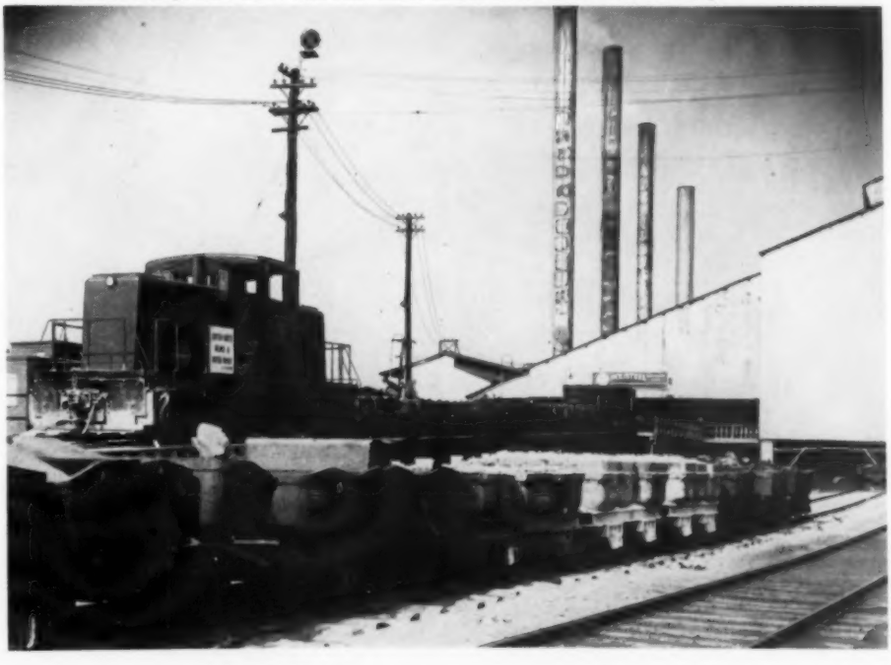
U. S. STEEL INCREASES ANNUAL INGOT CAPACITY

▲ At the start of 1954, the steel capacity of the United States was 124,330,410 net tons of ingots and steel for castings annually—the highest level ever achieved and an increase of 6,782,940 tons during 1953, according to American Iron and Steel Institute, on the basis of reports from the steel producing companies.

The new annual capacity figure of the world's largest steel industry is an increase of more than 32 million

LOCOMOTIVE WORKHORSE AT ATLANTIC STEEL

The Atlantic Steel Co. of Atlanta, Ga., keeps one of its General Electric Co. 80-ton locomotives busy 24 hours a day, seven days a week (except four hours for servicing) pushing 40,000 pounds of dead-weight raw scrap and charging stock into its open hearth furnaces. This 20-ton weight excludes the weight of the cars themselves. The incline shown is approximately an eight to ten per cent grade. During the weekly four-hour service period, the locomotive is given a complete lube oil, greasing, and bearing check. Because of the continuous process involved in the production of steel, the locomotives are not given major overhauls except when the weekly service indicates that such overhaul is necessary.



tons, or 35 per cent in the eight postwar years as a result of steel companies' large scale expansion and improvement programs. It is a gain of over 52 per cent since 1940.

The expansion of production facilities was indicated by the Institute on January 5, 1953, when it announced that "the annual capacity is rising toward an expected figure in excess of 123,000,000 tons of ingots and steel for castings." A few week later, the Defense Production Administration estimated that the national ingot capacity on January 1, 1954 would be slightly over 124 million tons.

Other producing facilities in the industry have been expanded and improved. Blast furnace capacity went up 2,621,150 tons during the past year and as of January 1, 1954, is rated at 82,001,390 net tons annually. Blast furnace capacity has increased about 47 per cent since 1940. Coke oven capacity was increased over 2 million tons in 1953 and is now rated at 73,239,540 net tons a year.

The new *weekly* capacity figure, on which the weekly operating rate will be based starting January 4 is 2,384,549 net tons of ingots and steel for castings, compared with 2,254,459 net tons at the start of 1953.

INSTALLS CONTINUOUS GALVANIZING LINE

▲ Wheeling Steel Corp. has reached the most important milestone in its long history of galvanizing, a field in which Wheeling has been pioneering for more than seventy years. The new continuous galvanizing line for the production of zinc coatings has been put into operation at the company's Martins Ferry, Ohio factory.

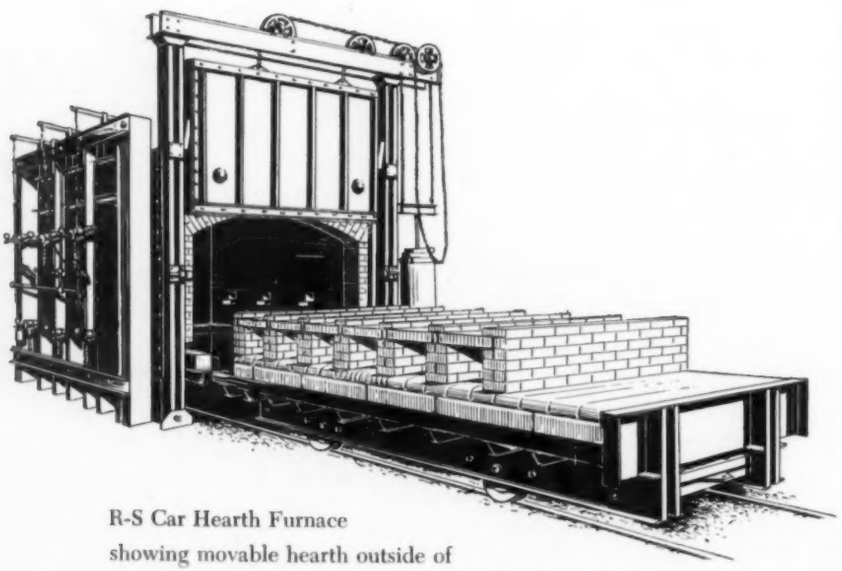
This line has been under construction for over a year, and it employs many new principles never before used in zinc coating. It is an exclusive process which has been developed over a period of years.

Top-rated speed of the line will exceed that of any continuous zinc coating line in operation. The new product from this line will be known as Wheeling "SofTite" galvanized. The product is greatly superior to any that has ever been known, and Wheeling confidently expects that this superior quality will open many new fields for the use of galvanized coatings.

FIRMS UNITE TO EXPAND RESEARCH ON BORIDES

▲ Three well-known companies have united forces to expand the activities of the Borolite Corp., which was recently formed to pursue research and development of various metal borides ("Borolites") for high temperature military and civilian applications, according to a joint announcement by the presidents of the three cooperating companies—Mr. Kenneth D. Mann, of Firth Sterling Inc., Pittsburgh, Pa.; Dr. Paul Schwarzkopf, of American Electro Metal Corp., Yonkers, N. Y.; and Major General Clinton F. Robinson, of The Carborundum Co., Niagara Falls, N. Y.

All three companies had previously engaged in separate research and development programs for atomic age materials. The joint statement said the Borolite Corp. was formed to concentrate funds and facilities for faster and broader development of new high temperature materials des-



R-S Car Hearth Furnace showing movable hearth outside of furnace for loading of heavy materials.

R-S
QUALITY FURNACES SINCE 1908

R-S FURNACE TYPES

Hi-Head ● Batch ● Rotary Hearth ● Continuous Belt Conveyor ● Continuous Chain ● Continuous Pusher ● Continuous Pusher Tray ● Pit ● Continuous Roller Hearth ● Car Hearth

AID TO GOVERNMENT

Clarence R. Burrell, vice president in charge of sales of Tool Steel Gear and Pinion Co., Cincinnati, Ohio, is shown being sworn in as Director of the General Components Division, Business and Defense Services Administration, Department of Commerce. Administering the oath of office is Charles F. Honeywell, BDSA Administrator. Mr. Burrell serves the organization under an executive rotation system by which the services of outstanding business men are made available to the government without compensation.

perately needed by government and industry.

American Electro Metal Corp. has assigned to the Borolite Corp. all patents, compositions, processes and techniques relating to borolite materials, and will provide research and some pilot plant production for the new company. The Carborundum Co. will draw upon its experience with abrasive, refractory, and powdered materials to produce and manufacture various borides. Firth Sterling Inc. has production know-how and equipment for certain powder metallurgy, processes, and will fabricate borolite products.

Borides, carbides, and aluminides, all part of the Borolite program, show promise of withstanding operating temperatures ranging from 1600-2000 F for turbo-jets and up to 7000 F for rocket nozzles and intermediate applications.

Dr. Schwarzkopf pointed out that while the Air Force supported research on aluminides, the Office of Naval Research, since 1946, has allotted large sums of money for boride research, not only because borides retain a great part of their strength at temperatures in excess of 2500 F, but also because they are composed of non-strategic materials. Civilian uses of borides, which are combinations of boron with such metals as zirconium, chromium, and molybdenum, appear to be in crucibles for melting metals, protector tubes for thermocouples, atomizing nozzles for metal spraying equipment, and electrical contacts—because of the borolites' excellent electrical conductivity, hardness and erosion resistance. Some borolites also possess light weight per unit volume and excellent resistance to oxidizing atmospheres.

In the initial stages the three participating companies will manufacture the borolite products which will be marketed by the Borolite Corp. with headquarters in Niagara Falls, N. Y.

J & L INCREASES COKE-MAKING FACILITIES

▲ Coke-making facilities at Jones & Laughlin's Pittsburgh Works' by-product coke plant were increased recently to produce an estimated 1½ million tons of coke annually.

A newly-installed battery of 79 coke ovens, costing $11,200,000, went

car hearth furnaces handle bulky jobs!

The R-S Car Hearth Furnace is a general purpose industrial furnace for heating heavy or bulky materials. It is used for heating metals for forging, rolling, hardening, annealing, normalizing, stress relieving and drawing. Heat source—oil, gas, or electricity. Temperatures inside the furnace can range from 600 to 2500° F. Forced recirculation may be used for temperatures up to 1500° F, direct firing for temperatures from 1000 to 2500° F.

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A SUBSIDIARY OF
HARDINGE COMPANY, INC.

R-S
QUALITY FURNACES SINCE 1908

WHY SHELL-MOLDED BRONZE BEARINGS COST LESS AND WEAR LONGER

National Bearing's carefully controlled *shell molding* practice makes extremely close-tolerance casting possible. This eliminates the need for costly machining and metal waste. It permits retention of a greater portion of the tough outer cast shell . . . *a guarantee of greater service life.*

Add to this the fact that if oil grooves are required, they can be cast in; if drilling is specified, castings are drilled prior to shipment so that they are ready for installation when received by you . . . and you have the answer to why *shell-molded* bearings cost less and wear longer.

And remember, six modern National Bearing plants insure quality workmanship and prompt delivery. They, in turn, are backed by extensive engineering and research facilities of the entire American Brake Shoe Company.

So investigate National SM castings for use as line shaft, crane, run-out table, and other similar replacement parts.

OTHER NBD PRODUCTS FOR STEEL MILLS

Bosh Plates	Stack Plates
Monkeys	Roll Neck Bearings
Tuyéres	Housing Nuts
Coolers	Babbitt Metals
Mantle Plates	Slippers

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

4930 Manchester Avenue, St. Louis 10, Mo.

into operation on December 1 when 18¼-tons of coal were charged into No. 5 oven of the new 79-oven P-4 Battery.

On hand to witness the initial charge of coal and discharge of coke were officials of J&L and the Koppers Company, builders of P-4 Battery.

The estimated production of the new P-4 Battery is 39,500 tons per month. It increases Pittsburgh Works' coke plant facilities to six batteries of 379 coke ovens capable of producing an estimated 125,000 tons per month—approximately 1½ million tons annually.

BLAW-KNOX TO BUILD MILL FOR MEXICAN FIRM

▲ Blaw-Knox Co.'s Lewis Machinery Division has received a contract for a combination rod and merchant mill to be installed for Cia Fundidora de Fierro y Acero de Monterrey, S. A., (which is also known as the Monterrey Steel Plant) at Monterrey, Mexico.

The order, which amounts to $4,500,000, including electrical equipment, is part of a large overall expansion program undertaken by the Monterrey Steel Plant, Mexico's oldest steel maker.

This new mill will establish Fundidora, which already has a dominant position in large structurals and rails, as the Mexican leader in the field of rod and merchant bar products.

Outstanding feature of the new mill will be the large tonnage potential despite its extreme versatility. An average of 35 tons per hour will be produced, based on Fundidora's wide product mix. The mill will have 22 rolling stands, of which two will be vertical mills for flat and skelp edge control, and will roll at delivery speeds from 600 to 4,500 ft per fpm.

In building this mill, Lewis Machinery Division will use some existing equipment in the plant. Some parts, not directly affecting production of the mill, will be manufactured in Mexico. International General Electric has been selected as the subsupplier of electrical equipment.

Lewis has completed about half of the engineering for this new mill and delivery is scheduled for early fall of 1954. Blaw-Knox has just completed the design, production and shipment of a combination rod and merchant mill for De Wendell & Co. in France.

REPUBLIC ANNOUNCES NEW PRICE SYSTEM

▲ A new procedure for the pricing of its steel mill products was introduced December 15 by Republic Steel Corp. The procedure applies to pricing hot rolled carbon bars only, but it is intended that it will be extended to Republic's other steel mill products in due course.

In substance, Republic, in the pricing of hot rolled bars, will establish a policy of selling and delivering such products to any common carrier destination at a published delivered base price; in other words, including in its delivered base prices, all transportation costs.

Republic has established a new mill price for hot rolled carbon bars at each of five principal points as follows: Chicago, Ill., $4.22 per 100 lb; Cleveland, Ohio, $4.21 per 100 lb; Youngstown, Ohio, $4.20 per 100 lb; Buffalo, N. Y. $4.18 per 100 lb, and Gadsen, Ala., $4.18 per 100 lb.

Republic will deliver to any common carrier destination at these prices within the county or counties covered by the switching area immediately adjacent to each mill provided Republic can choose the transportation method. If a customer wishes to take delivery at the mill in his own transportation equipment, he may do so at the above mill prices.

Prices have likewise been established for delivery from each of the above mill points to common carrier destinations in each of the 1481 counties throughout the United States into which Republic normally ships its hot rolled carbon bar products, and Republic is prepared to make quotations for delivery to any of the other 1593 counties on short notice.

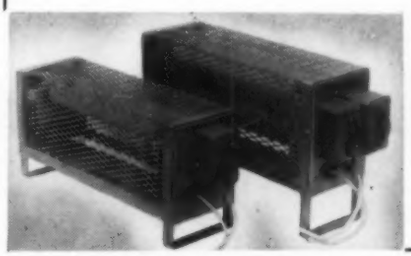
In announcing the change in pricing procedure, Mr. Norman W. Foy, vice president in charge of sales, said that the delivered cost to customers would be substantially the same under the new procedure as under the existing procedure. In some cases there may be slight reductions and in others slight increases, but in neither case will the change be significant.

Specific benefits to customers of Republic's bar mill products according to Mr. Foy are:

GUYAN HEATER UNITS FOR INDUSTRIAL APPLICATIONS

• Guyan natural convection heater answers the problem of small, hard to heat places (such as locomotive cabs, crane cabs, pump houses and small offices) requiring a dependable, long life heater.
Consisting of corrosion resistant aluminum chromium alloy wire wound on ceramic forms and mounted within expanded steel housings, these heaters can be furnished from 1500 watts thru 7500 watts for 110, 220, 250, 440, 500 volts DC or AC, single or three phase.

Guyan heaters are designed to withstand the hard service and abuse that is commonly experienced in industrial mills and mine use. Please advise voltage, wattage required and type heater when ordering or requesting quotation.

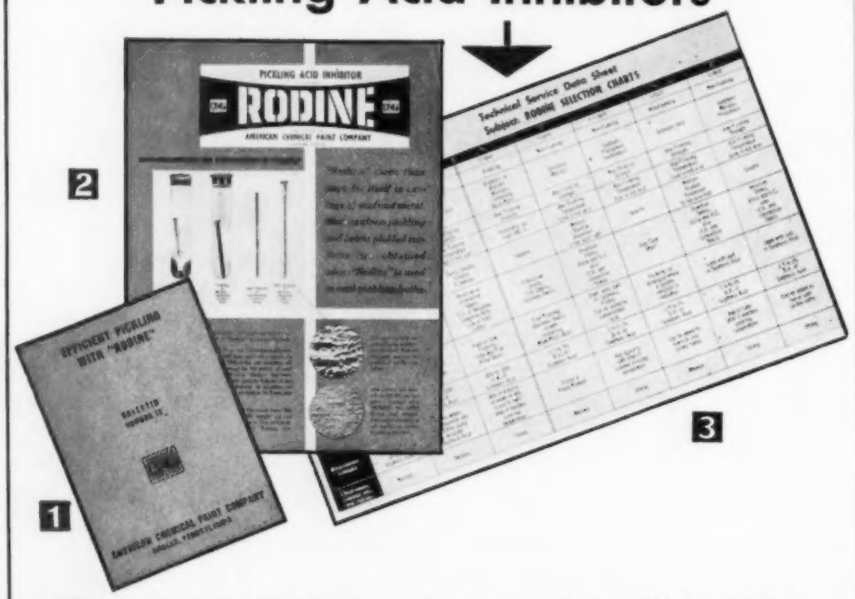


GUYAN
MACHINERY COMPANY
LOGAN • WEST VIRGINIA

New Data Available on . . .

RODINE®

Pickling Acid Inhibitors



1 The standard reference work on pickling, "Efficient Pickling With RODINE" — Bulletin Number 13 — is now available in a new, revised edition.

2 This new 4-page general descriptive folder presents essential information on "Rodine" pickling acid inhibitors.

3 The recently revised "RODINE SELECTION CHART" gives characteristics of and uses for typical "Rodines" used with sulfuric and muriatic acids. Technical Service Data Sheet No. 13-1-1-4.

Use coupon below for free copies of the literature described above.

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Company Name .....

Address .....

City ..... State .....

1. Republic's delivered base price is instantly available to the customer from published material supplied to him by the company without the necessity for his computing the transportation charges.
2. Republic produces hot rolled carbon bars at several mills. The customer can determine from the published information exactly what products, size ranges, etc., are produced at each mill and which mill has the lowest delivered prices to his destination.
3. The customer avoids all of the bookkeeping requirements involved in handling transportation charges. He has no freight damage claims to prosecute and no transportation to arrange.

The principal advantages to Republic are:

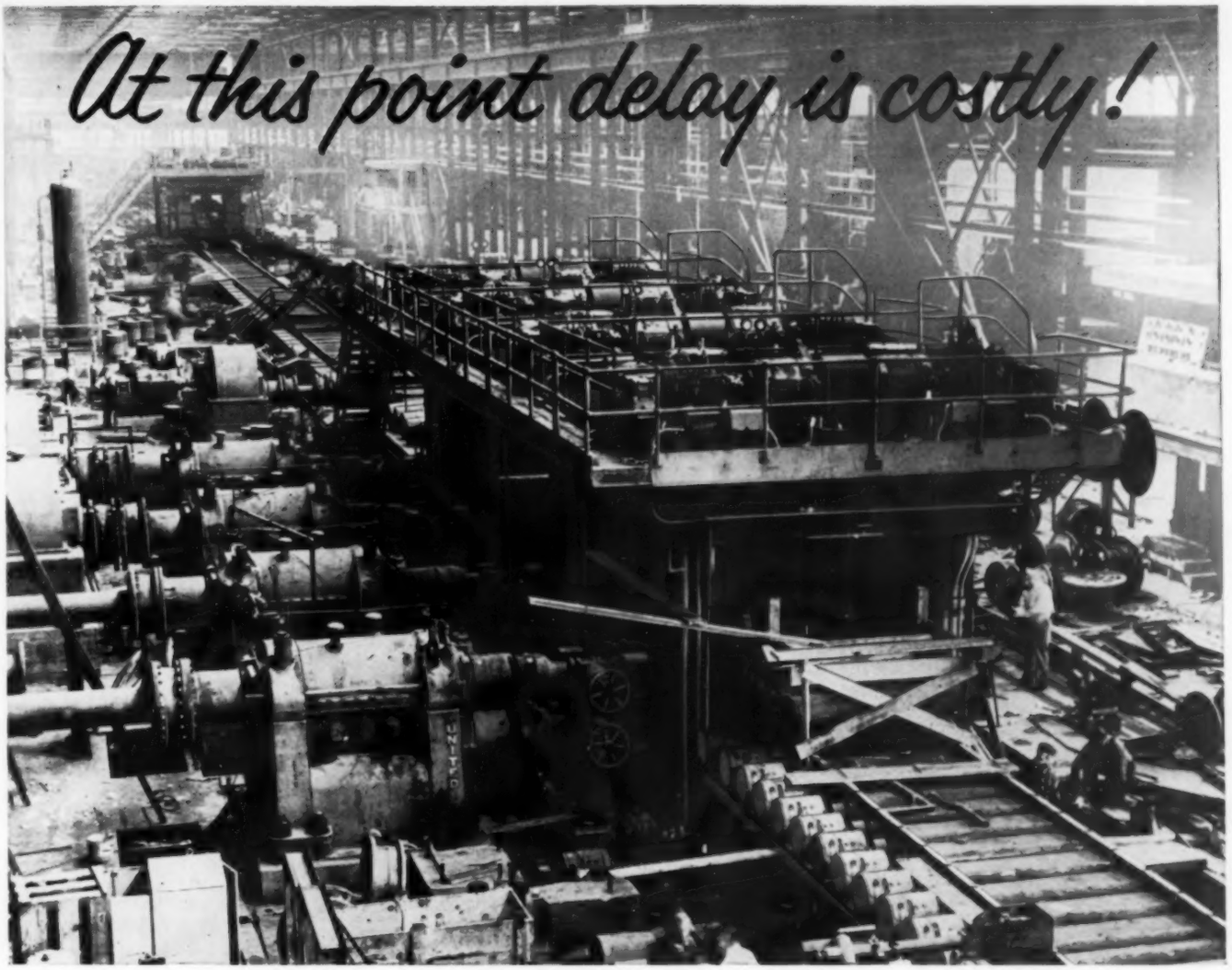
1. Salesmen can make delivered price quotations to the customer from information that he carries with him. Previously, it was necessary to refer such quotations back to traffic experts at the home office for the calculation of delivery charges.
2. It will relieve the sales organization and the traffic department of the necessity of making numerous calculations from the fantastically complex rail and truck freight rate structures in connection with each individual order.
3. The simplification of the pricing structure will result in a substantial reduction of the clerical work in the sales, traffic and accounting departments.

ANNOUNCE PURCHASE OF WELDING COMPANY

▲ American Brake Shoe Co. has purchased the welding machinery business of Leader Welding and Manufacturing Co. of Berkeley, Calif.

The complete line of automatic welding equipment will be sold by the welding products department of American Manganese Steel Division of the company and will be made available to Amsco distributors.

All of Leader's inventory, tools and machinery used in the manufacture of welding equipment were involved in the sale. The services of Turner G. Brashear, a partner in the Leader Co., will be available to the American Manganese Steel Division under contract.



Pittsburgh Steel Company's new hot mill at Allenport, Pa., during installation

THE FINEST steel mill equipment becomes a real asset only after it is properly installed and in operation.

The machinery pictured above is typical. Until actual production of finished sheets began, the 28 millions of dollars required to complete this facility earned not one penny.

On this project, as on thousands of others, Commercial Contracting Corporation completed its job—the installation of finishing stands, runout tables, and other equipment—in record time.

Specialists in all types of industrial construction and machinery installation, CCC has built an enviable reputation for doing quality work quickly and economically.

Why not call in this seasoned industrial team to handle your own plant alterations or expansion program?

Whether your project is large or small, every aspect of the work will be supervised by experts, expedited by top management.

CCC services, available to you individually or under one PACKAGE contract, include:

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"National" brushes have *uniformly* high quality over a wide range of application . . . simplify brush selection . . . contribute to in-plant standardization on fewer types and sizes.

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"National" brushes reduce commutator maintenance through low friction, peak commutating ability and long life . . . cut costs and keep production rolling.

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Procurement Officer

"National" brushes come in more stock and catalog items than any other brand . . . *plus* the exclusive "National" *standardized* brushes sold at low, flat prices regardless of quantity . . . faster deliveries, lower costs.

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"National" brushes are packed for quick identification . . . handle easy, stack fast in fewer and sturdier cartons.

How good is really good brush performance?
—Buy "National" brushes and see!

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Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

INSTALLS HIGH-SPEED TELEGRAPH SYSTEM

▲ Armco Steel Corp. recently inaugurated a new 2800-mile high-speed telegraph system which will speed the flow of messages between the company's headquarters at Middletown, Ohio, and its district offices and plants.

The system more than doubles the capacity of the communications facilities now used by Armco. It is engineered so that it can be expanded readily to handle increased volume and additional stations as the growth of Armco operations may require.

The new system will save time that was formerly lost by the manual retransmission of messages at points en route. Now messages from any point on the network will flash instantly to the communications center at Middletown. There an operator will note the destination and connect the message to the proper circuit. The message will arrive in page form, ready for use.

All messages are automatically numbered to prevent loss. The machines used are automatic and the possibility of human error is minimized. When any station wishes to send a message to several points, automatic transmitters at Middletown send it on to any number of stations.

Messages arriving at the Armco communications center can be received in the form of perforated tape which is run through a machine, transforming the message to a punched card, which permits use of the information for many purposes — such as the preparation of invoices and sales statistics.

LAST OF OLD FURNACES SHUT DOWN AT DUQUESNE

▲ Operation of the five remaining furnaces of the old No. 1 open hearth shop of U. S. Steel's Duquesne Works were discontinued on December 24, the company announced. Originally a 20-furnace shop, five of the furnaces had been shut down in 1947 and ten late in 1952 and early last year.

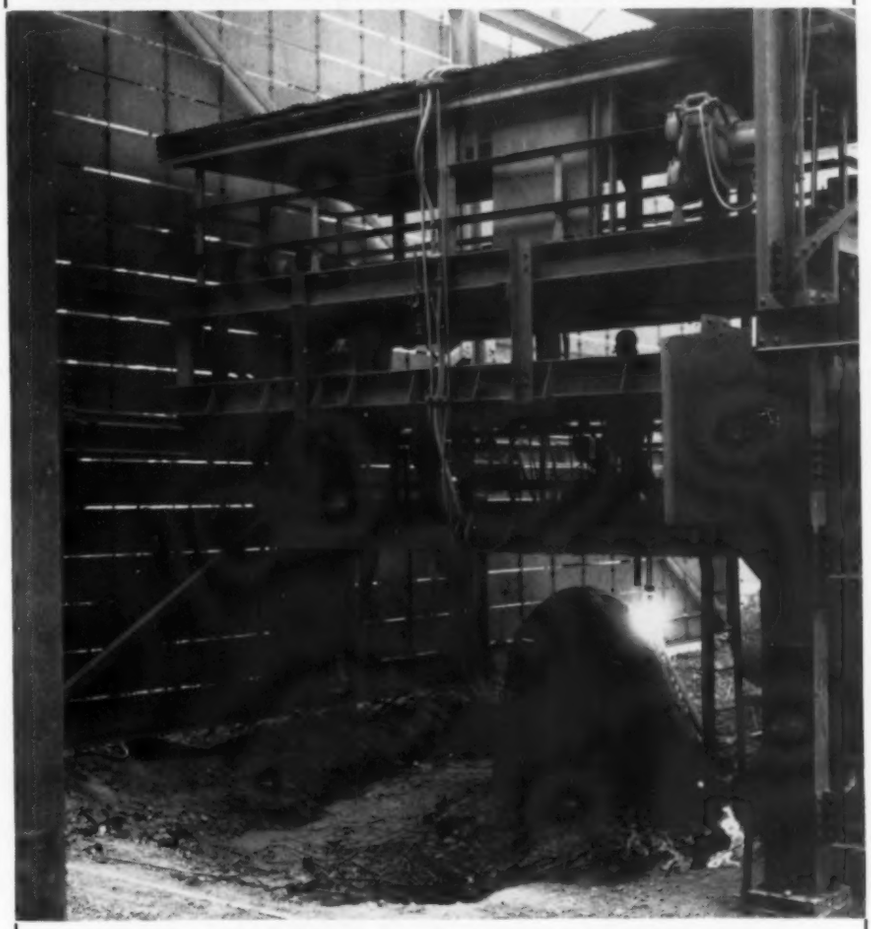
The five remaining furnaces had been kept operating because of the unusual demand for steel. All of the steel from this shop has been going

(*Please turn to page 206*)

TITZEL

STEEL MILL EQUIPMENT

SKULL AND BUTTON BURNING CRANE



Crane cutting button in cinder yard of steel mill.

Bridge travel cutting speed is adjustable for various size buttons and skulls. Crane has rapid traverse for positioning.

MANUFACTURERS OF

- CAPPING CRANES FOR INGOT MOLDS
- STOPPER ROD DRYING OVENS
- HOLDING OVENS
- JIB CRANES, WALL AND FLOOR TRAVELING
- SPECIAL EQUIPMENT

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PITTSBURGH 22, PA.

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BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AUTOMOTIVE AND
AERONAUTICAL TESTING FACILITIES

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HALL
BUROMIN
CALGON

steel is made

RESULTS TELL THE STORY

Every advance toward higher combustion efficiency in the steel industry has demanded better automatic control and instrumentation. Hagan equipment and Hagan methods have always been in the lead in solving the problems and have contributed to the success of many new fuel-burning practices.

Hagan installations in the plants of the major steel producers indicate the diversity of the design, development and application problems solved by Hagan engineers.

Automatic Combustion Control for boilers has advanced from the simple systems for gas and stoker fired units to the complex systems required for simultaneous firing of several fuels in a single furnace. Hagan pioneered the automatic control systems for each successive step.

Similar advances have occurred in metallurgical furnace practice, with the added complexity of reversal of direction of firing and the operation of extremely heavy dampers. Furnace types using Hagan Automatic Control and Instrumentation include billet heating, single and multiple-zone slab heating, open hearth and blast furnaces, and soaking pits.

Gas mixing stations, based on measurement and calorific value or on volumetric ratios, are among the numerous applications where Hagan Automatic Control and Instrumentation have contributed to the effective use of waste fuels.

Among other diversified applications are: Measurement and control of air delivery from blast furnace blowers, with automatic compensation for barometric pressure and air temperature changes; automatic control and instrumentation for coke oven crossover mains, exhausters, stacks and underfiring; natural gas flow metering, with fully automatic pressure and temperature compensation; line type metering of liquid fuel for record and control; oxygen flow measurement and control.

Our staff of engineers will be pleased to consult with you on your automatic control and instrumentation problems.

HAGAN CORPORATION

Hagan Building

Pittsburgh 30, Pennsylvania

(*Continued from page 203*)
to other plants in the district, which are now able to produce sufficient steel for their own needs.

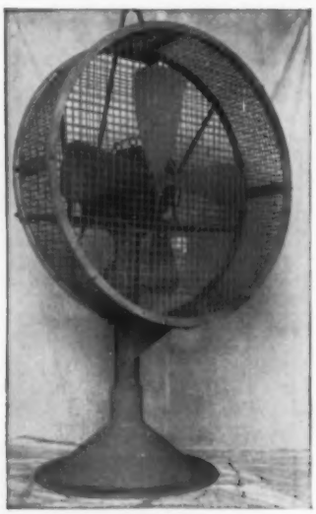
Duquesne No. 1 shop was started in 1900 and the heats tapped are the smallest in the Monongahela Valley plants of U. S. Steel. Other steelmaking facilities at Duquesne show increases which help to off-set the loss of the No. 1 shop. Since the start of World War II the No. 2 open hearth shop has been modernized and shows an increase of 200,000 tons yearly. Also, a modern electric furnace shop was built there with a yearly capacity of 160,000 tons.

Other increases in capacity in U. S. Steel's Pittsburgh district plants since the start of World War II have been accomplished through the building of open hearth shop No. 5 at Homestead with a yearly capacity of 2,040,000 tons, and modernization of a number of existing open hearth shops in the district with a total increase in these shops of 1,268,000 tons in yearly capacity.

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

245 MAIN ST: HARMONY, PA:

Work has started on dismantling the 15 furnaces which had been previously shut down at the Duquesne No. 1 shop. No time has been set as yet for dismantling the remaining furnaces.

TO BUILD FACILITIES FOR McLOUTH STEEL

▲ Rust Furnace Co. will design and construct a new slab heating furnace and five batteries of soaking pits for the McLouth Steel Corp. at its Trenton, Mich. plant near Detroit.

The new facilities, undertaken in McLouth Steel's $100 million expansion program, will serve the hot strip mill for increased production.

The new slab reheating furnace will have a capacity of 125 tons per hour, and is of the Rust continuous, zone-controlled, triple-fired, non-recuperative type. It will have an inside width of 27 ft and an effective heating length of 80 ft. Oil-fired, the slab heater will be end charged and discharged, with completely automatic control of combustion and furnace temperatures.

The five new batteries of soaking pits of two holes each will double the mill's soaking pit capacity. They will be two-way, top-fired, of the recuperative type.

RESUMES PRODUCTION THREE DAYS AFTER FIRE

▲ Despite a $1,000,000 fire that destroyed the main factory buildings, offices, engineering department, and laboratory of C & D Batteries, Inc. plant at Conshocken, Pa. on Sunday, November 29, limited production was resumed in three days. Approximately 80% of the company's floor area was destroyed.

The fire raged uncontrolled through C & D's block-long plant for more than four hours. Even before the fire was out, management met to survey the damage and to decide what steps should be taken to get back into production. The check of the plant showed that the casting room, machine shops, generators, and shipping department escaped the fire.

Immediate negotiations were begun to obtain temporary production and office facilities in nearby properties. Production space was leased in

(*Please turn to page 211*)

Oil Immersed

mechanically interlocked power outlet

Type 620-A3GX Safety Switch with Receptacle and Plug Interlock — Closed view and with oil tank lowered showing arrangement of component Parts.

A SAFETY POWER outlet to provide dependable operation under adverse conditions and convenience for readily connecting portable equipment such as welding machinery, conveyors, mixers, agitators, etc. Manually operated, mechanically interlocked switch handle and plug makes it impossible to insert or remove the plug while the switch is in the closed position.

Standard features of the Rowan Type 620-A-3GX Safety Switch include the following: completely oil immersed; manually operated disconnect switch of the quick-acting contactor type with renewable contacts; equipped with ROWAN time-tested AIR-SEAL fuses; sealed-off terminal compartment; safety disconnect jack; straight through conduit entrance; provision for padlocking switch in the OFF position; enclosure designed to meet the requirements of NEMA Type XI — also available for NEMA Type VIII, Class 1, Group D locations, designated Type 620-A-1-3GX.

Ccmplete information available from Rowan representative in principal cities of the United States.

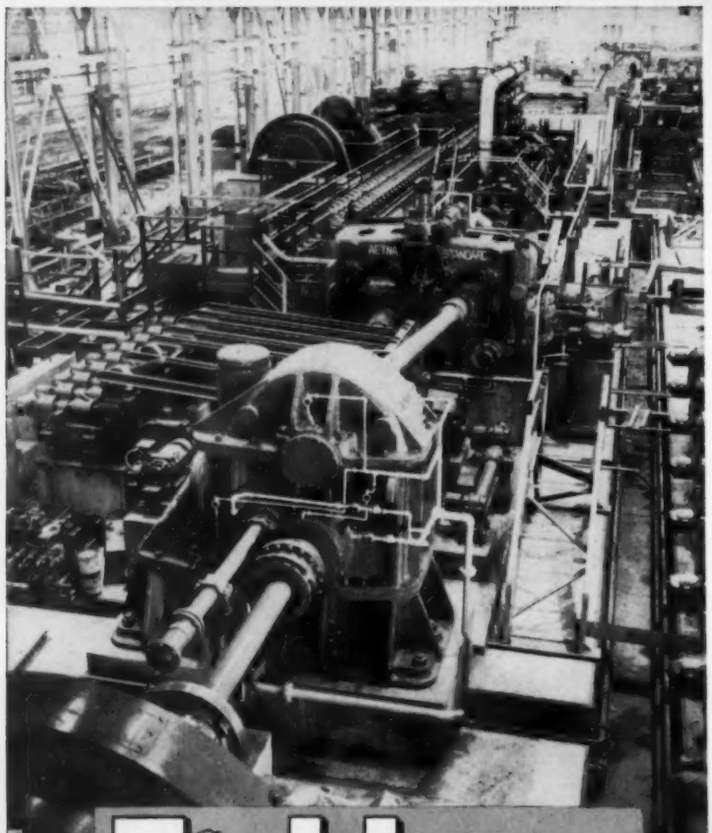
ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

New
Seamless Tube Mill
Colorado
Fuel and Iron Corp.
Pueblo, Colorado

CFI

Building Erection and
Mechanical Installation
OF MILL BY
Eichleay

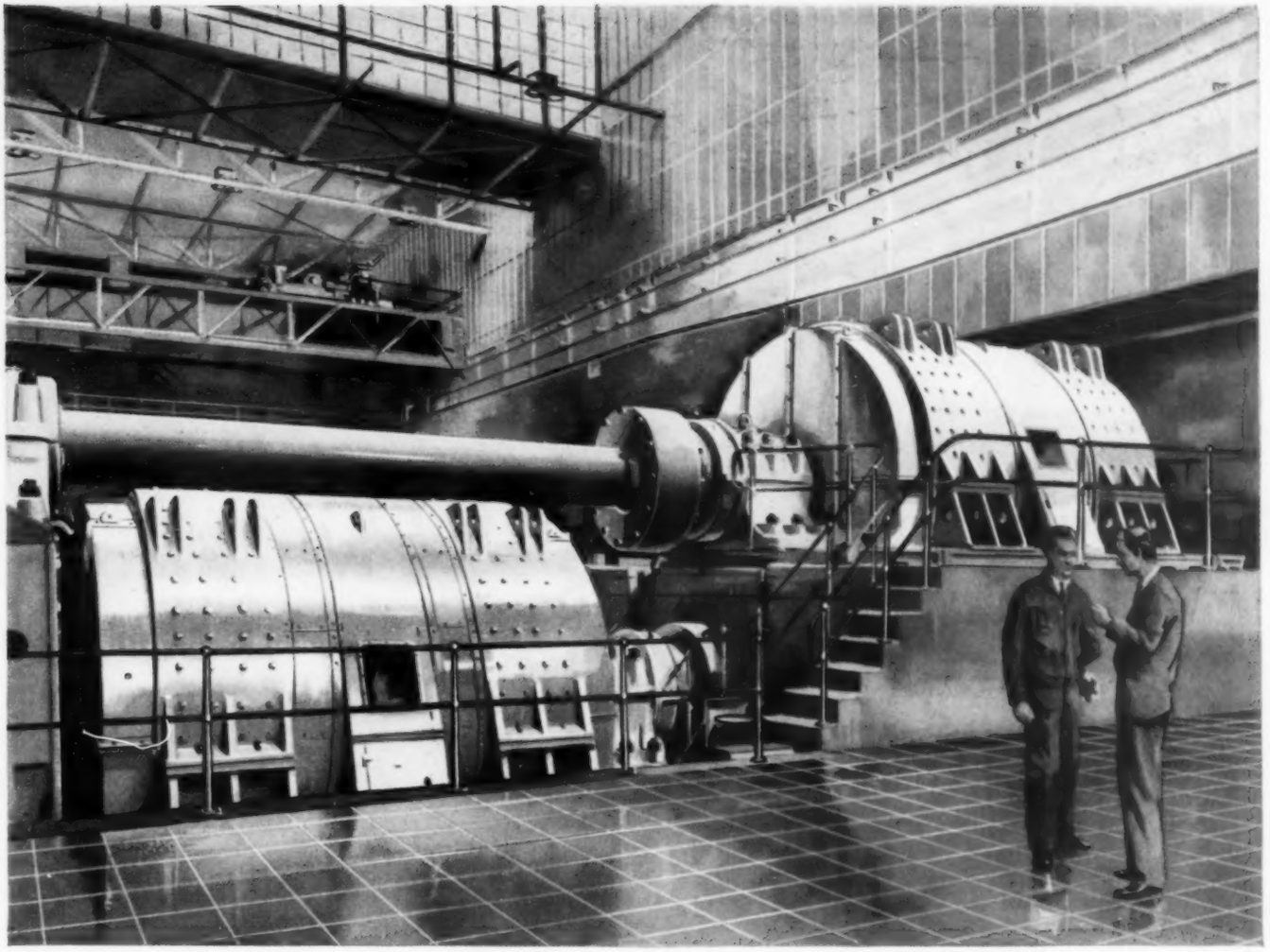


The new seamless Tube Mill is the first such mill to be built in the West. We congratulate the management for its initiative, its vision and its courage which made this important development possible. We are happy to have had a part in this great expansion program.

Our participation consisted of the complete erection of the building to house the mill and the mechanical installation of the new Aetna-Standard Seamless Tube Mill.

Eichleay
ESTABLISHED 1875

CORPORATION
33 South 19th St., Pittsburgh 3, Pa.
681 Market St., San Francisco 5, Calif.



Modern rolling mill practice . . .

The twin drive, with each roll driven separately, thereby eliminating the pinion stand, was pioneered by 'ENGLISH ELECTRIC' as early as 1922. Shown here are the main motors of a double armature twin reversing drive developing 27,600 peak horsepower, for a 45 inch slabbing mill. The rapid acceleration and deceleration required is obtained by the 'ENGLISH ELECTRIC' standard reversing mill Control System, employing the 'ENGLISH ELECTRIC' Magnavolt rapid response control exciter.

The Company has supplied many drives for both hot and cold rolling mills, including over fifty main drives for hot reversing mills, as well as many other hot mill drives for continuous and semi-continuous strip, sheet, wire rod and merchant sections. Also, the long experience of 'ENGLISH ELECTRIC' in this field provides a wealth of information on all electrical problems . . . power and substations, cabling and ventilating and complete layouts.

'ENGLISH ELECTRIC'

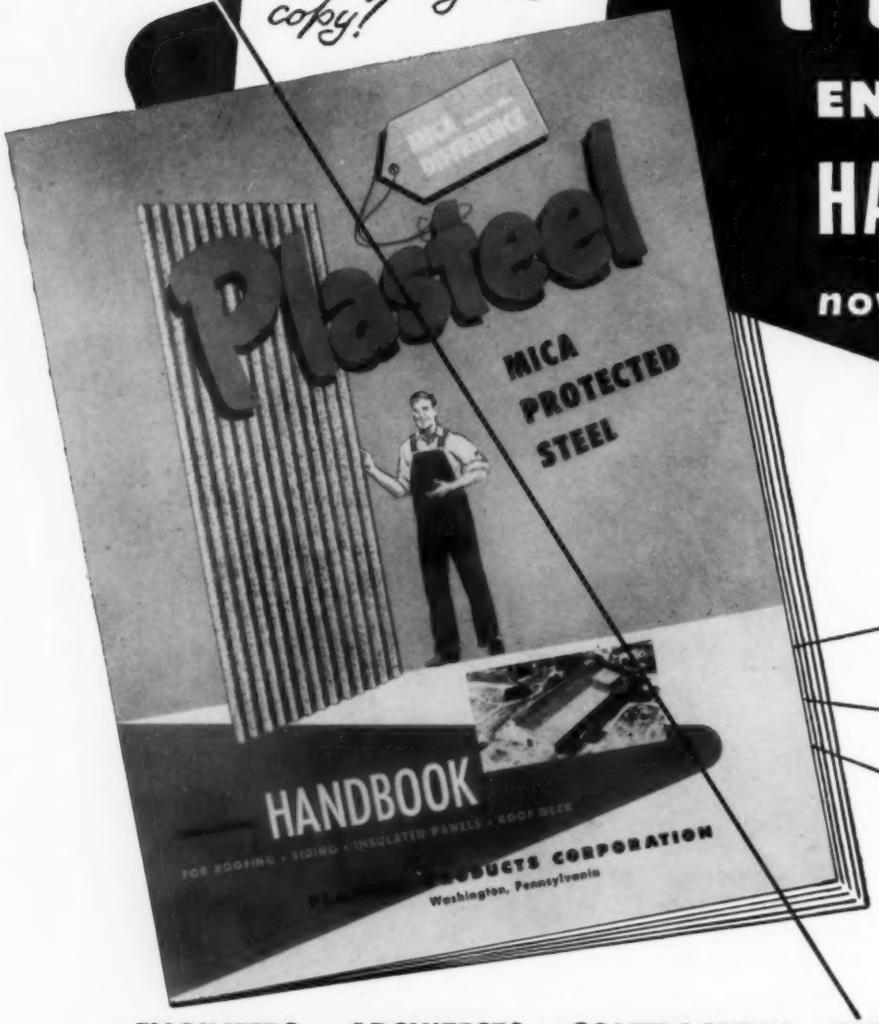
rolling mill drives

Offices in Halifax, Montreal, Ottawa, Toronto, Winnipeg, Calgary, Edmonton, Vancouver
English Electric Company of Canada Limited. Head Office and Factory: St. Catharines, Ontario

NEW Plasteel ENGINEERS' HANDBOOK now available

MEMO

Write for your copy!



ROOFING and SIDING

ROOF DECK

INSULATED PANELS

ENGINEERS • ARCHITECTS • CONTRACTORS • MAINTENANCE MEN

This New Engineers' Handbook is a valuable construction guide for the use of Plasteel Products. Complete instructions and specifications—fully illustrated to simplify the efficient and economical erection of Plasteel—the only protected metal roofing and siding with Mica advantages!
Mica does make a big difference!

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PLASTEEL PRODUCTS CORPORATION
Washington, Pennsylvania

ISE-1-54

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Washington, Pennsylvania

Please Rush New Plasteel Engineers' Handbook

Name..... Title.....

Company.....

Address.....

City..... State.....

MANAGEMENT GROUP TOURS U. S. PLANT

Vicenza (Italy) Productivity Area Management Study team visits new Cleveland, Ohio plant of Ohio Electric Manufacturing Co., to study American production methods.

(*Continued from page 206*)
one of the plants of the Alan Wood Steel Co., and the Quaker Chemical Products Co. made adequate space available for administrative and clerical forces.

On Tuesday, December 1, utility lines were connected and work started on cleaning up the salvageable portions of the plant. Charging of new batteries that escaped the fire began Wednesday at noon and grid casting began Thursday morning, December 3.

Suppliers gave C & D priority on new equipment and materials started rolling in. By December 1, the administrative and clerical forces were working and by December 2 production forces started coming back. Friday, December 11, saw approximately 65 per cent of the production force again at work.

WEIRTON PUTS RELINED FURNACE IN OPERATION

▲ Weirton Steel Co.'s No. 1 blast furnace, is now in operation following a complete reline.

No. 1, a 25 ft 6-in. diameter furnace, is one of four furnaces at Weirton Steel. It was originally built in 1919, and was enlarged to its present size in 1950.

During the reline of the furnace, complete new brick lining was installed in three stoves and a partial lining in one stove. A complete new cast house was erected together with all new iron and cinder runners. The slag granulating pit was eliminated and additional cinder pot spouts were added with a complete new roof over all the pots.

Additional gas cleaning facilities were added which will help to minimize the amount of air pollution at the blast furnaces. The stockhouse required a major rebuild, and automatic coke-weighing facilities were installed.

Completely new furnace charging-control equipment was added, and a new brick and steel substation building was erected to house the new equipment.

Due to the age of the furnace, a considerable amount of platework was required, and a complete new whirler was installed in the gas cleaning system.

ANNOUNCES NEW QUARTERS FOR PITTSBURGH OFFICE

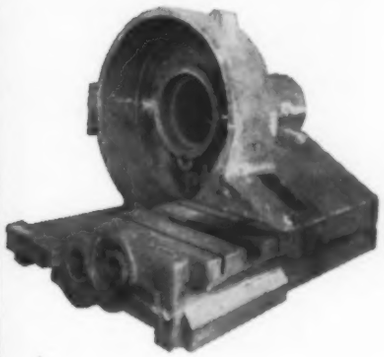
▲ The DeLaval Separator Co. of Poughkeepsie, N. Y. announces that it has moved its Pittsburgh office to 2420 Grant Building, Pittsburgh 19, Pa. The new quarters will enable the company to increase its customer service through the addition of personnel and added service improvements.

APPOINT DISTRIBUTOR FOR NEW ENGLAND AREA

▲ National Alloy Division of Blaw-Knox Co., Pittsburgh, Pa., announced that Metallurgical Products Co. of Brookline, Mass., will distribute its products in New England. Metallurgical Products Co., founded in 1947 and specializing in new materials of engineering and heat-treating equipment, has representatives in Salem, Mass., Wethersfield, Conn., and Schenectady, N. Y.

Hyde Park
RED CIRCLE Rolls ALLOY-CHILLED
Gray Iron Castings

Castings of any size up to 80,000 pounds. Hyde Park facilities are equal to your every requirement



Machine Castings
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Shoe Plates
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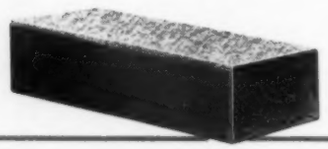
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

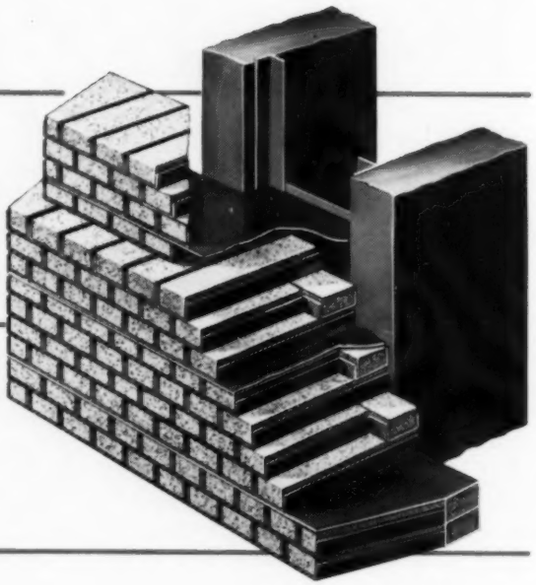
HARBISON-WALKER

CHROMEX B—an extremely hard fired chrome-magnesite refractory having unusual constancy of volume and strength at high temperatures.

METALKASE—the pioneer metal-encased basic brick possessing an unusual combination of desirable properties.



CHROMEX—a chemically-bonded chrome-magnesite brick having excellent spalling resistance.



Typical section of open-hearth furnace front wall built of METALKASE. For maximum stability steel plates are used at every fourth course vertically. These are tack-welded to steel bars which in turn extend behind the buckstay and are free to move vertically.

MAGNEX—a chemically-bonded magnesite-chrome brick—highly basic and of low spalling tendency.

H-W MAGNESITE—the standard burned magnesite refractory for more than half a century.

THERMAG—a hard burned magnesite-chrome refractory possessing enhanced physical properties.

H-W CHROME—a hard burned chrome brick especially adapted for various specific uses.

FORSTERITE—the only commercially produced magnesium-silicate brick—suited for certain particular applications.

H-W PERIKLASE—an exceptional high-magnesia brick of unusual high-temperature stability.

OTHER HARBISON-WALKER BASIC REFRACTORIES

H-W Magnamix
H-W Washington Dead Burned Magnesite Grains
H-W Washington Furnace Magnesite
H-W Special Furnace Chrome
Plastic Thermolith Batch
Thermolith and Other Cements

BASIC REFRACTORIES

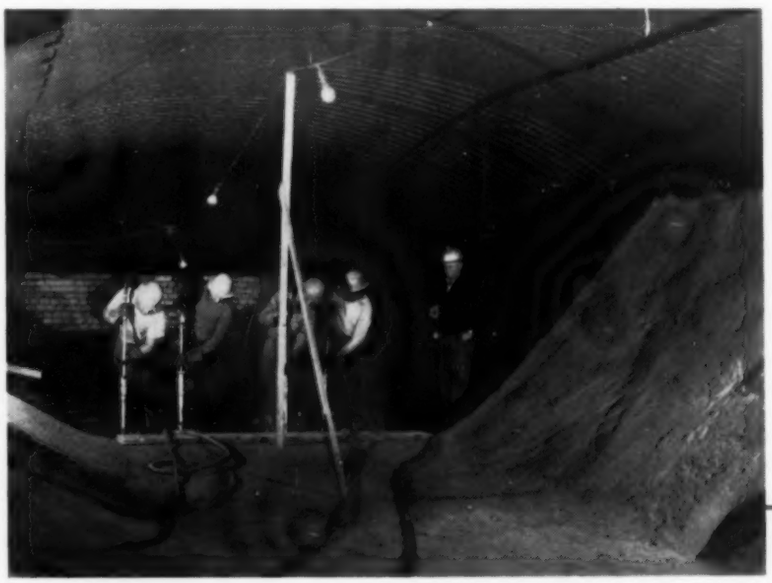
serve the varied and specialized needs for metallurgical furnaces

Shown at the left are the various brands of Harbison-Walker basic refractories. They include classes especially suited for each particular need in open-hearth and electric steel furnaces, soaking pits and various other furnaces.

Among the brands listed here are types and classes established as standards for furnaces employed in the metallurgy of ferrous and non-ferrous metals and alloys.

The superior performance of Harbison-Walker basic refractories is the result of: (1) a thorough knowledge of the requirements gained through close cooperation with producers of metals and alloys; (2) extensive and continuous original research; and (3) the use of top quality raw materials processed in modern plants under close laboratory control. Harbison-Walker uses the most up-to-date methods and equipment to insure the quality and dependable uniformity of basic refractories.

(*Above*) In basic linings of electric furnaces, METALKASE are used in the upper side walls and provide maximum resistance to spalling and to slagging action. Lower side walls and sub-bottom are built of H-W MAGNESITE. MAGNAMIX or H-W DEAD BURNED MAGNESITE forms the monolithic banks and bottom.



(*Left*) H-W MAGNAMIX bottom section in a new open-hearth furnace. Air hammers are used to ram the material into a dense, monolithic working hearth of the desired thickness and contour.

HARBISON-WALKER REFRACTORIES CO.

AND SUBSIDIARIES

GENERAL OFFICES • PITTSBURGH 22, PENNSYLVANIA

World's Largest Producer of Refractories

Products of fame

wherever there's flame...

Keeping flame on the job is the business of brick. Refractory brick to contain the flame and put it to work with efficiency and economy in the furnaces of industry.

Grefco refractory products have long been famed for doing this job reliably. Grefco brick, special shapes, mortars, plastics and castables to hold the heat and help spew out products for the service of industry.

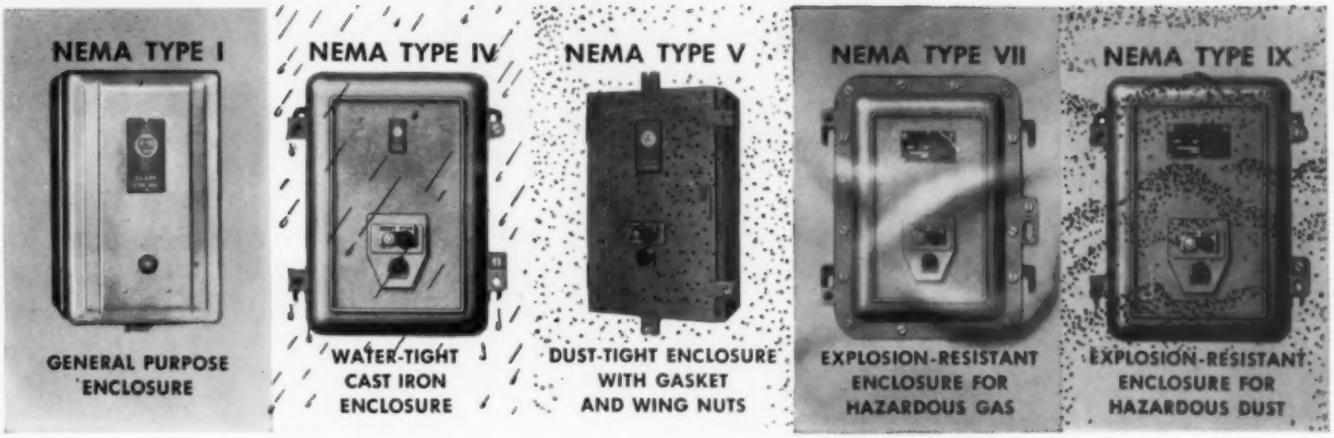
If your operation requires *flame*, here's the name . . . *Grefco!*

A Complete Refractories Service . . .

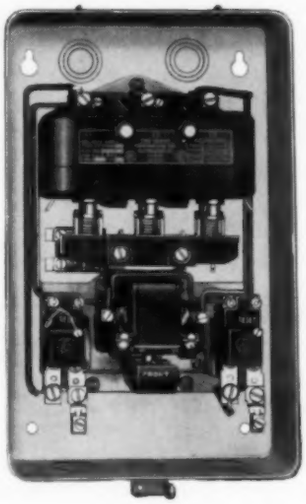
GREFCO

GENERAL REFRACTORIES COMPANY
Philadelphia

GENERAL REFRACTORIES COMPANY



for every operating condition
use CLARK TYPE "CY" STARTERS

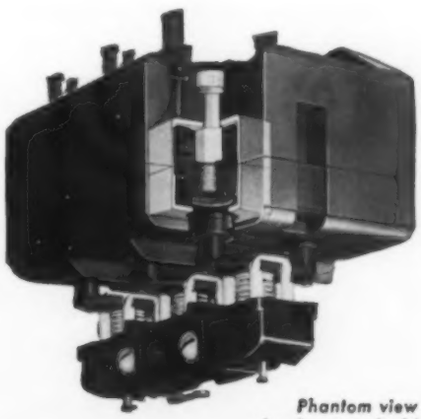


In every industry, including those where hazardous atmospheres prevail, CLARK TYPE "CY" STARTERS are giving utmost satisfactory service.

The incomparable new multi-turn magnetic blowouts combined with twin-break contacts, and the rest of the operating mechanism, are enclosed in types of cabinets to protect against adverse conditions or dangerous atmospheres.

Type "CY" starters, Sizes 2 and 3, employ an entirely new principle of arc interruption. The arc is extinguished by the effect of the blowout coil, concentric with the contact. The magnetic field quenches the arc either by lengthening or confining it. In its forced rotation it moves continually from a hot to a cold spot—minimizing burning or pitting of contacts. The ingenious design of the arc chamber prevents carbonization and the accumulation of hot gases between wiring terminals—minimizing phase-to-phase failures. Sizes 0 and 1 use the same general mill type construction as the larger sizes.

- **No filing, dressing or cleaning of contacts!**
- **No tools necessary to inspect contacts!**
- **Easy to change moving contacts!**
- **Stationary contacts changed quickly!**
- **Remove only two screws and one pin to change coils!**
- **Remove only four screws to take out stationary magnet frame!**
- **Power circuit contacts available with springs in complete packaged service kits for ease in stocking!**



Phantom view showing Arc-shield

***You'd better try* CLARK TYPE "CY"**

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

Keep NATIONAL Carbon Brick on hand for MAINTENANCE

TRADE-MARK

KEEP THESE STANDARD SIZES ON HAND FOR EMERGENCY!

13½" x 6" x 3" series
9" x 6" x 3" series
9" x 4½" x 2½" series

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Write for Catalog Section S-6210

If you think of carbon only in terms of complete furnace linings, check these other important locations in and around the furnace where "National" carbon brick and shapes will also save time and money as a maintenance refractory:

- ✓ ***RUNOUT TROUGHS***
- ✓ ***CINDER NOTCH LINERS***
- ✓ ***CINDER NOTCH PLUGS***
- ✓ ***SPLASH PLATES***
- ✓ ***SKIMMER PLATES***

. . . and Many More!

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

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District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg

Personnel News...

Thomas R. Moxley, assistant general manager of Wheeling Steel Corp.'s Steubenville, Ohio, works has retired. Mr. Moxley entered the employ of Wheeling Steel in December, 1927, as master mechanic of the by-product coke plant. Prior to his Wheeling Steel employment, Mr. Moxley was first employed by Tennessee Coal, Iron and Railroad division of U. S. Steel as machinist apprentice and progressed to mechanical engineer. Succeeding Mr. Moxley is **E. H. Cauger** who was superintendent of the utilities department. **M. L. Bernstein,** formerly chief plant engineer, succeeds Mr. Cauger. **N. W. Blakely** is now chief plant engineer.

Charles Knox has been appointed divisional manager, Crouse-Hinds Co.'s Philadelphia, Pa. division. Associated with the company's Philadelphia office for the past thirty years, Mr. Knox heads a sales territory made up of eastern Pennsylvania, southern New Jersey, Delaware and Maryland.

Herbert A. Long, former chief engineer at Pittsburgh Steel Co.'s Allenport, Pa., works, now is chief engineer for Pittsburgh Steel Co. with full supervision over engineering at the Allenport Works, the Monessen, Pa., plant and the Thomas Strip Division at Warren, Ohio. **Donald C. Duvall** was appointed works manager at the Monessen plant, succeeding **William J. Huston,** who is retiring. Mr. Duvall formerly was assistant works manager. **Clarence M. Feehan** has been promoted from assistant superintendent of the open hearth department at Monessen to superintendent, succeeding **Karl Leinberger,** who also has retired.

Charles H. Squarcy was named superintendent of the blast furnace department at Inland Steel Co.'s Indiana Harbor, Ind., works. He succeeds **James F. Peters,** who has retired after 40 years of service with Inland. Mr. Squarcy has been assistant superintendent of blast furnaces.

Frank A. Burns was appointed public relations representative at Fairless works of United States Steel Corp. Since 1950, Mr. Burns has been director of public relations in United States Steel's Pacific-Southwest district in Los Angeles. In charge of the field office at Fairless Works, the largest fully integrated steel plant ever to be built at one time, Mr. Burns will maintain close liaison with the newly established Philadelphia district office.

Gifford M. Randall has been placed in charge of development work for Kaiser Engineers on industrial and government engineering and construction projects on the West Coast. He will be located at the firm's 1924 Broadway, Oakland, Calif., headquarters. Mr. Randall joined the Kaiser organization in 1942 as senior engineer on design and construction of the first installations at the Kaiser Steel plant at Fontana, Calif. In 1945 he became office engineer, and since 1950 has acted as project engineer.

Thomas T. Crowley has been named staff assistant to the executive vice president of Crucible Steel Co. of America, Pittsburgh, Pa. Prior to joining Crucible, he was assistant to the president of Inland Steel Container Co.

C. V. Gregory was promoted to the newly-created position of manager of district sales for the Reliance Electric & Engineering Co., Cleveland, Ohio. Succeeding Mr. Gregory as Pittsburgh, Pa. district manager is **Elwood H. Koontz,** branch manager of Reliance's sales office at Newark, N. J., since November, 1950, whose present duties will be taken over by **F. Raymond Obenchain,** sales engineer there for the past three years. **C. B. Allen, Jr.** was named as Detroit, Mich. district manager of Reliance. Mr. Allen succeeds **J. L. Buell, Jr.,** who has resigned after 18 years as Reliance's Detroit district manager to join another manufacturing concern in Detroit. Mr. Allen comes to his new post in Detroit from Buffalo, N. Y., where he has been a sales application engineer for Reliance for the past three years. Promotion of three sales application engineers was also announced: **John Drollinger, Jr.,** manager of the Reliance branch sales office at Toledo, Ohio, for the past two years, becomes manager of the renewal

THOMAS R. MOXLEY

E. H. CAUGER

CHARLES KNOX

C. V. GREGORY

parts and repair division in Cleveland. **William C. Mitchell,** who has been a sales application engineer at Baltimore, Md., succeeds Mr. Drollinger in Toledo. **Robert O. Gee,** an application engineer in Reliance's applied engineering department in Cleveland, becomes manager of service. In addition to these appointments, it was also announced that **W. G. Hall,** who will continue to supervise the in-plant operations of renewal parts and repair, is designated superintendent of the

ELWOOD H. KOONTZ

enlarged department, and also that in the new service set-up, **N. R. Joy** and **S. G. Dunning** continue their present assignments as assistant manager and consultant, respectively. **Antony C. Schettler** was named Baltimore, Md. branch manager of Reliance. **Wilmer K. Schlotterbeck** becomes Buffalo, N. Y. district manager of Reliance.

John Brandenburg was named vice president in charge of sales, for the American Manganese Steel division of American Brake Shoe Co. **William E. Crocombe, Jr.** was appointed central sales manager, and **John H. Baker** was made district sales manager. Mr. Brandenburg, who was formerly sales manager for the Amsco division, will be located at the company's Chicago, Ill., sales office. Mr. Crocombe, who prior to his new appointment was district sales manager in St. Louis, Mo., will be located at the Amsco plant in Chicago Heights, Ill. Mr. Baker, formerly a sales engineer with Amsco, will be located at the division sales office in St. Louis, Mo.

E. H. Frank has been appointed plant superintendent of Washington Steel Corp., Washington, Pa. Mr. Frank has been with the firm since 1946, and prior to joining Washington Steel, he spent a number of years with Eastern Stainless Steel Corp. in Baltimore, Md. Other new appointments include the names of **Harry Beecham,** new superintendent of the finishing department at Washington Steel, and **Harold Anderson,** newly named as superintendent of the shipping department.

Don Allshouse has been appointed general advertising manager of Continental Foundry & Machine Co. Mr. Allshouse has been advertising manager of the Copes-Vulcan Division of Continental since its formation in June, 1952. Mr. Allshouse's new duties will involve direction of all advertising for Continental Foundry & Machine Co. as well as the Copes-Vulcan Division. He will maintain offices in both Erie and Pittsburgh, Pa.

Hugo E. Johnson was named vice president of Lake Superior Iron Ore Association, Cleveland, Ohio. Mr. Johnson has been assistant manager of the project development group of the Battelle Memorial Institute, Columbus, Ohio, for the last five years. Previously, he was associated with Youngstown Sheet and Tube Co., and the United States Steel Corp. in research and engineering positions.

George D. Griffiths was appointed as manager of roll sales, and **Charles L. Flanigan** as assistant manager of roll sales for Ohio Steel Foundry Co., Lima, Ohio.

Albert A. Baker was appointed executive assistant, J. A. Zurn Mfg. Co., Erie, Pa. Mr. Baker was formerly plant superintendent. **John L. Derby** has been named plant manager to succeed Mr. Baker. Mr. Derby was associated for many years with Blaw-Knox Co., immediately prior to present, as assistant works manager of Foote Division, Nunda, N. Y.

William B. Ferguson until recently associated with the Freyn Engineering Department of Koppers Co., Inc., has formed the firm of William B. Ferguson & Associates with offices at 33 North LaSalle Street, Chicago 2, Ill. With a group of experienced engineers the new company is prepared to handle electrical engi-

WILLIAM B. FERGUSON

neering projects and drafting as well as problems involving skip hoists and other blast furnace specialty items. Prior to his association with Freyn, Mr. Ferguson was electrical engineer at Duquesne, Pa., Works and South Works in Chicago, Ill., of U. S. Steel Corp.

Dave Wooster was named as works engineer of Basic Refractories, Inc., Gabbs, Nev., plant. Prior to joining Basic Refractories, Mr. Wooster was employed as mechanical engineer and head of the equipment

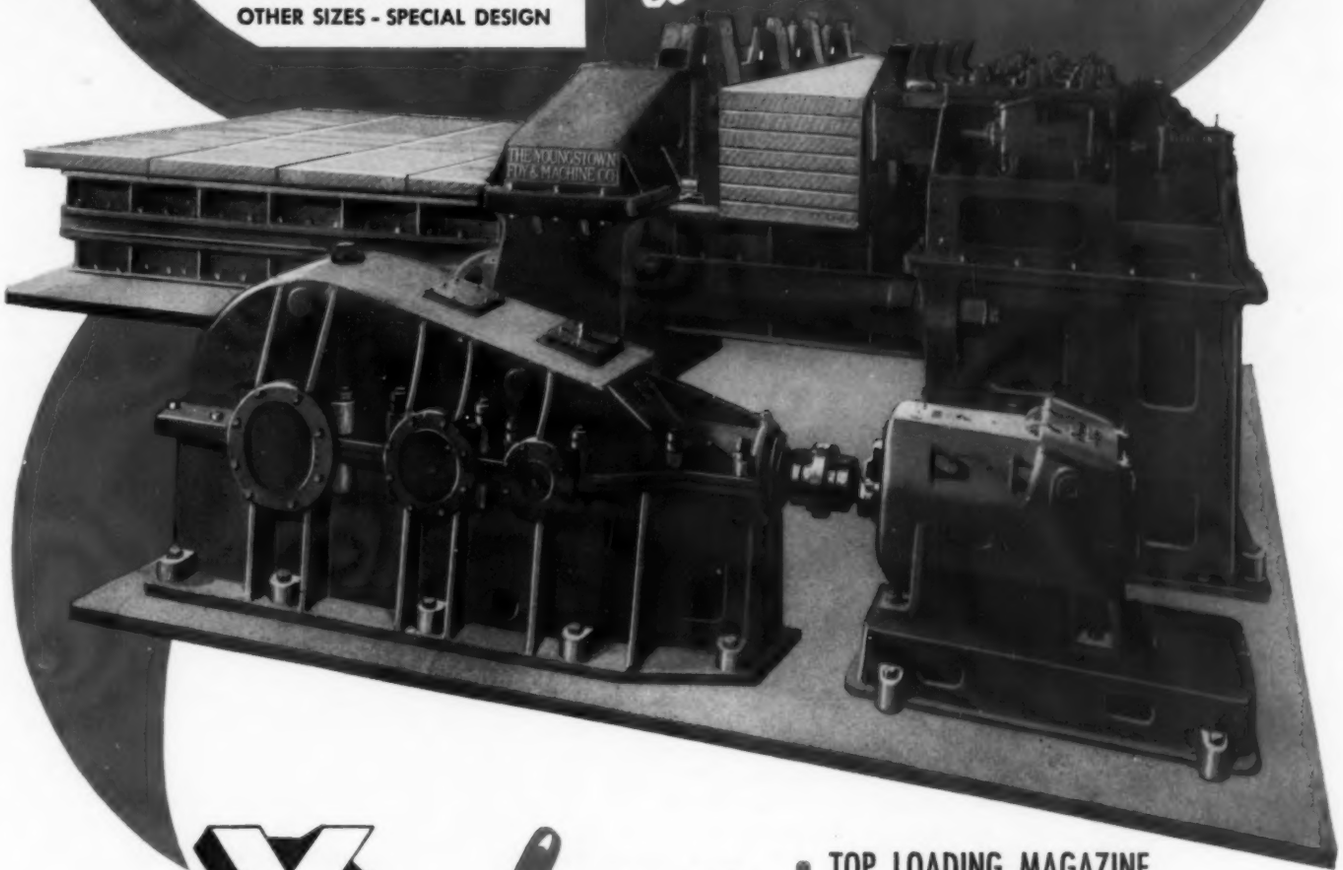
YOUNGSTOWN

DOUBLE FURNACE PUSHER
SLAB UNPILER AND FEEDER

built better to do a better job!

SLAB SIZES

LENGTH — ONE ROW: 18'-0" MAXIMUM
TWO ROWS: 6'-0" MINIMUM
WIDTH: 24" TO 45"
THICKNESS: 3" TO 7½"
OTHER SIZES - SPECIAL DESIGN



F&Y *features*

- TOP LOADING MAGAZINE
- SINGLE OR DOUBLE ROW OF SLABS
- MOTOR DRIVEN RAM RACKS
- ADJUSTABLE FOR VARIOUS SLAB SIZES

SPECIAL PUSHERS DESIGNED FOR ANY OPERATING REQUIREMENTS

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

15

how to lower cable costs...
specify OKOLITE-OKOPRENE

Specify electrical cable that is designed for tough jobs—that can resist heat, flame, moisture, dirt, mechanical damage and corrosive chemicals and you will reduce cable costs. Cable that can survive such steel mill conditions will give the best service at the lowest cost. You avoid unnecessary maintenance expense, production time losses and the cost of replacing cable that has worn out prematurely when you put Okolite-Okoprene cables on the job.

Okolite-Okoprene has proved itself to electrical men in the steel industry by a long record of trouble-free operation. The famous Okoprene protective sheath, an exclusive Okonite neoprene compound, will outperform any of the usual types of cable covering.

Additional life is given to the cable because it is made by the unique strip process which applies the insulation and sheath simultaneously. Long-lasting, high mechanical and electrical strength is assured by the perfectly centered conductors which are uniformly vulcanized in a continuous metal mold.

Bulletin IS - 1053 provides more information on the outstanding performance of Okolite-Okoprene. Write for it today to The Okonite Company, Passaic, N. J.

OKONITE OKONITE SINCE 1878 *insulated cables*

75th ANNIVERSARY

1718

engineering section, explosives department, U. S. Naval Ordnance Test Station Inyokern, China Lake, Calif.

George Burnham, IV, has been named assistant to vice president of United States Steel Corp., located in Philadelphia, Pa. Mr. Burnham has been serving as supervisor of personnel and training with the Oliver Iron Mining Division in Duluth, Minn.

Peter R. Letcavits has been appointed general superintendent of Republic Steel Corp.'s 98-in. strip

PETER R. LETCAVITS

mill in Cleveland, Ohio. Mr. Letcavits succeeds **G. N. Harmon** who has been assigned other duties in the corporation. Succeeding Mr. Letcavits as superintend-

LOUIS G. BRIEGEL

ent of the Enduro Division in Massillon, Ohio, will be **Louis G. Briegel** who has been assistant superintendent.

W. L. Fabianic was named executive assistant to the vice president and director of research at Laclede-Christy Co., St. Louis, Mo.

Harold W. Sweatt, president of Minneapolis-Honeywell Regulator Co. since 1934, was elected chairman of the board, succeeding **Mark C. Honeywell,** who was named honorary chairman. **Paul B. Wishart,** vice president and general manager of the company, was elected to succeed Mr. Sweatt as president. The management changes coincided with the retirement of five officials: **W. L. Huff,** director, executive vice president and former treasurer; **R. P. Brown,** vice president and chairman of the board of the company's industrial division in Philadelphia; **George A. DuToit,** vice president in charge of manufacturing; and **L. Morton Morley,** vice president and formerly in charge of sales for the industrial division.

James F. Baxa has been appointed vice president and general manager of sales of Ackermann Manufacturing Co., a subsidiary of Wheeling Steel Corp., Wheeling, W. Va. **George E. Martin** will take over the manufacturing duties previously performed by Mr. Baxa as general manager of the Ackermann factory. Mr. Martin has been serving as general superintendent of the Ackermann factory.

G. N. Harmon was named superintendent of the electrical department at Republic Steel Corp., Youngstown, Ohio, and **R. C. Stern** was made superintendent of the masonry department. Mr. Harmon became associated with Republic in Warren in 1926 and held num-

G. N. HARMON

erous supervisory positions there before becoming electrical superintendent in Youngstown in 1943. In 1947 he was transferred to Republic's Cleveland strip mill.

Alex C. Davidson, Jr. was made assistant director of industrial relations — safety for Industrial Relations Department, American Steel and Wire Division, U. S. Steel Corp. **Robert J. Grenfell** was named supervisor of labor relations. **Edwin O. Kunler** assumed the newly created post of supervisor of safety. Moving to the Joliet, Ill., plant from Cleveland is **Rea C. Helm, Jr.,** who becomes superintendent of industrial relations of that plant.

John D. Carter has joined Youngstown Sheet and Tube Co. and will be located in general offices at Youngstown, Ohio. He will do public relations work under the direction of the assistant to the president. **Paul C. Humbert,** for 14 years a personnel man in

hot days will come again—
be prepared with . . .

LINTERN
AIRE-RECTIFIERS

It is fast becoming standard practice to provide normal working temperatures by means of air conditioning throughout industry at the worst spots — wherever the handling of hot metal increases already excessive temperatures.

Outstanding among the advantages resulting from the use of Lintern Aire-Rectifiers for cranes and pulpits are increased production due to men working under normal, healthful conditions; improved personnel relations; reduction of wild cat work stoppages; elimination of relief men and premium rates. These savings soon equal the capital investment for an Aire-Rectifier.

Cab is air conditioned with Lintern Aire-Rectifier.

Since we have a complete line of models to meet all requirements — and priced according to capacities — the total investment for Lintern Aire-Rectifiers is the lowest consistent with good performance. *Maintenance is a minor item.*

May we suggest that you anticipate your requirements and order now so as to be prepared for the hot weather that is sure to come, thereby benefiting by: (1) delivery in ample time to maintain a high level of production regardless of the heat and (2) installation before the rush season with its increased costs.

THE LINTERN CORPORATION
ROUTE 20, EAST • PAINESVILLE, OHIO

industrial relations at the Indiana Harbor, Ind., plant, will handle public relations in the Chicago, Ill., district. He will work under the direction of the assistant to the president and of the manager of Chicago district operations.

Charles W. Keene was named superintendent, masonry department, maintenance division at U. S.

CHARLES W. KEENE

Steel's Duquesne, Pa., works. Since 1946 Mr. Keene has been serving as assistant superintendent, masonry.

C. Burton Clark, a member of the research department of Harbison-Walker Refractories Co., Pittsburgh, Pa., has been named senior mineralogist.

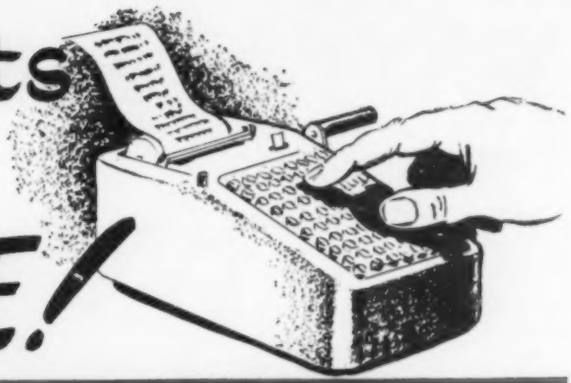
T. P. Butler, formerly president of Heyl & Patterson, Inc., Pittsburgh, Pa., was elected chairman of the board. **H. R. Edelman, Jr.,** former executive vice president,

H. R. EDELMAN, JR.

was elected president to succeed Mr. Butler. At the same meeting **E. W. Kahle** was elected as executive vice president and **J. F. Page** as secretary-treasurer of the company.

Arthur C. Wilby has retired as vice president of United States Steel Corp. in Chicago, Ill., and will be succeeded by **Edward C. Logelin.** Before becoming vice president in 1946, Mr. Wilby for eight years was

Set your own costs on DOWN TIME!



Shutting down one machine can shut down an entire department or mill. Downtime costs make the extra price of Ajax Dihedral Couplings insignificant. If you have misalignment troubles you can't afford to be without Ajax Dihedral Couplings.

Cross section shows exclusive design of Ajax Dihedral Couplings. They handle misalignment heretofore considered excessive. Backlash held to lubrication film requirements. Lubricant sealed in, dirt sealed out. All gear teeth hardened to 50-55 Rockwell C. Tell us your misalignment troubles.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

director of public relations for United States Steel in the Chicago district. In 1941, Mr. Logelin was named assistant director of public relations in the Chicago district and five years later succeeded Mr. Wilby as director of public relations.

Albert W. Groesbeck was named assistant superintendent of the electrical department at Republic Steel Corp.'s Warren, Ohio, district steel plants. Mr. Groesbeck has been an electrical engineer for Republic since 1946.

C. E. Buchan was named to the newly created position of general sales manager of Electric Machinery Mfg. Co., Minneapolis, Minn. Mr. Buchan has been the

C. E. BUCHAN

Cleveland, Ohio, district manager for the past twenty-five years. His successor as Cleveland district manager will be **J. J. Wall,** for the past four years a sales engineer in the New York, N. Y. district office.

J. A. Keogh, vice president and comptroller, Allis-Chalmers Mfg. Co., Milwaukee, Wis., retired December 31. Mr. Keogh has been with Allis-Chalmers since 1904 at which time he joined the company as an accountant in the West Allis works accounting department.

C. J. Moore, former manager of railway and motive power sales for Electric Storage Battery Co., Philadelphia, Pa., has been made industrial products sales manager. **W. E. Nyce** has been appointed manufacturing manager, industrial products. **L. E. Wells,** former chief engineer, has been made director of research and engineering, industrial products.

Reuben W. Pelto was named sales manager of Ready-Power Division of Ready-Power Co., Detroit, Mich. One of the company's earliest employees, Pelto has served in numerous service and sales capacities in the last 25 years.

James P. Murray, Jr., now senior salesman for Dingle-Clark Co. in the Pittsburgh, Pa., district, is appointed vice president in charge of that area. He succeeds the late **Harry M. Leathers.** Mr. Murray has been with Dingle-Clark Co. since 1936. **Robert G. Smith,** now purchasing agent, has been transferred to the construction sales department with headquarters in the Cleveland, Ohio, office. Mr. Smith has been with the company for the past 13 years, until 1945 as assistant to the purchasing agent and office manager. **G. S. Wilkinson,** since 1947 assistant purchasing agent, is named purchasing agent to succeed Mr. Smith.

Walter C. Thompson has been elected president of Torrington Co., Torrington Conn., to succeed **Lester J. Ross,** who died November 14, and **Ray B. Nichols** has been elected executive vice president to succeed Mr. Thompson. **N. Russell Clarke,** president of the Westfield Mfg. Co., of Westfield, Mass., a subsidiary, has been elected director for the unexpired term of Mr. Ross. **Byron T. Virtue,** chief engineer of Torrington's Bearings Division, has been promoted to general sales manager.

Jerome L. Lindberg has been named assistant to the director of mechanical maintenance for Colorado Fuel and Iron Corp., Pueblo, Colo. Mr. Lindberg had been serving as industrial engineer since 1952.

Obituaries

J. D. Donovan, president of the Association of Iron and Steel Engineers in 1933, died at his home in Massil-

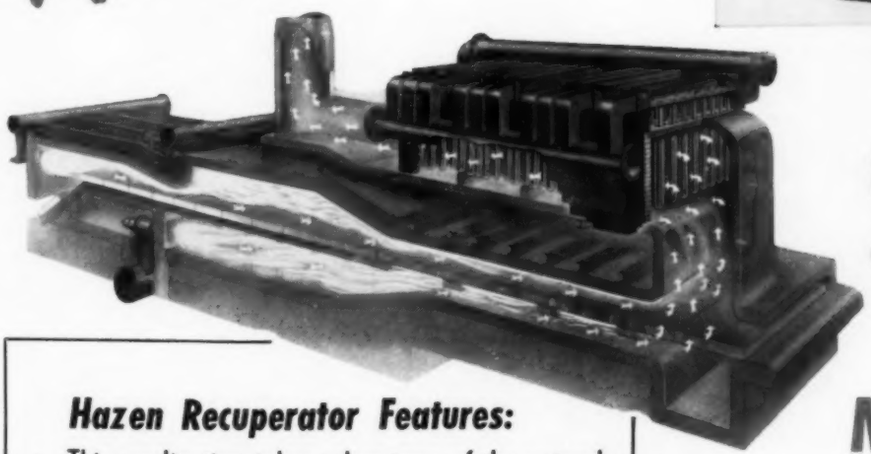
J. D. DONOVAN

lon, Ohio, on January 9. Mr. Donovan, who was one of the pioneers in the electrification of the steel indus-

(*Please turn to page 228*)

HAZEN FURNACE RECUPERATOR

the only 100% American Metallic Recuperator



100% Protection on Service!

Hazen Recuperator Features:

- This application takes advantage of the natural upward flow of flue gases.
- Less stack draft is required.
- Greater percentage of flue gases reach recuperator.
- Increased preheat . . . due to availability of a larger percentage of flue gases at higher temperatures.
- Economies in initial cost . . . by reducing the required amount of excavating and furnace foundation.
- Further economy . . . by reducing the length of flue ordinarily required from furnace to stack.
- Greater accessibility for ease of cleaning.
- Walkways may be provided around the recuperator for convenience of inspection and cleaning.
- Recuperator, flue and stack may be supported from steel work independent of the furnace bindings.
- Recuperator may be applied above an existing furnace with a minimum loss in outage time.

Made of American steel and alloys . . . by American labor . . . for meeting American high performance standards

Consult us about improving the production and economy of your furnace operations

HAZEN ENGINEERING CO.

PARK BLDG., PITTSBURGH 22, PA.

TELEPHONE COurt 1-7030

3

Fully Crowned Tooth Design Can Be Used To Solve Your Long-Standing Coupling Problem

A major improvement in gearing for power transmission—a fundamental improvement in gear tooth design that practically eliminates all "end tooth and tip" contact and provides greater freedom of axial movement distinguishes Amerigear Couplings from common gear-type couplings. Amerigear Couplings offer many more advantages than are obtainable with the common basic designs. The Amerigear Crowned Tooth Design can be applied wherever couplings are required. There are many instances where this design has been utilized to simplify power transmission mechanisms and add reliability to their performance in a measure heretofore found impossible.

If your problem arises from excessive offset or angular misalignment, tight back lash requirement, space limitations, high speeds and loads, or any combination of these, the solution is best made by the utilization of the Amerigear Fully Crowned Tooth. Amerigear engineers are available for consultation.

AMERICAN FLEXIBLE COUPLING COMPANY
ERIE, PA., U. S. A.
Originator of the Amerigear Fully Crowned Tooth
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In Canada: CANADIAN ZURN ENGINEERING, LTD.
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Amerigear
Fully Crowned Tooth Design Solves Wide Range of Power Transmission Problems.
Crowned Tip Contacts Root of Internal Gear Tooth in Sleeve, Accurately Piloting Sleeve With a Ball and Socket Action.
Amerigear
*Trade Mark Reg.
THE ONLY GEAR TYPE COUPLING WITH FULLY CROWNED TEETH
Oil Seals of Amerigear Couplings Are As Advanced In Design, Performance, And Effectiveness As Is The Amerigear Fully Crowned Tooth.
Pat. & Pat. Pending
Chamfered to Eliminate Interference With Sleeve of Tooth Fillet and Allow Contact on True Flank of Gear Tooth.
Crowned Flank Carries All the Load and Provides for Correction of Lateral and Angular Misalignments When Required.
Also manufacturers of the original "Oldham Type" American Flexible Coupling

Comparison Of Amerigear Fully Crowned Tooth Design With Gearing Of Conventional Gear-Type Couplings Shows How "End Tooth And Tip" Contact Is Practically Eliminated And Why Greater Freedom Of Axial Movement Is Provided By Amerigear Fully Crowned Tooth Design (dotted lines indicate gear teeth of conventional gear-type coupling).

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ERIE, PA., U. S. A.

Please send me further information regarding AMERIGEAR COUPLINGS with the fully Crowned Teeth and Catalog No. 501.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

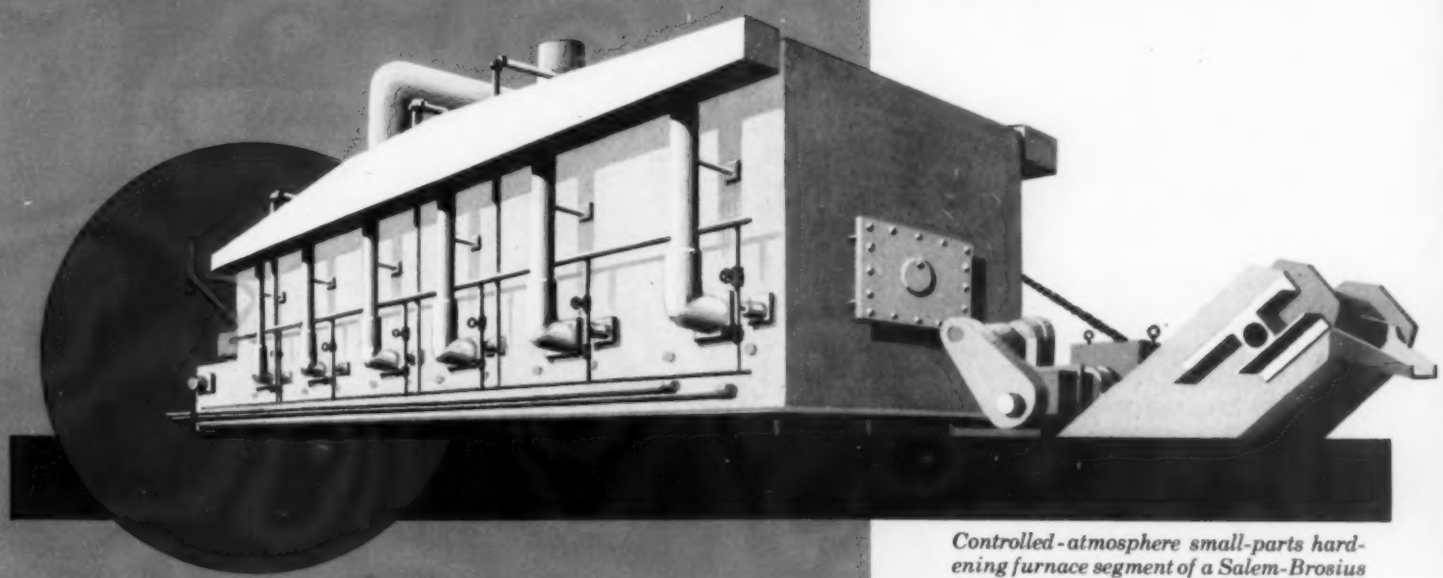
Please attach to your business letterhead

Salem-Brosius has a bad habit

that means profit to you!

Salem-Brosius has the unfortunate habit of going to the extra trouble of engineering more quality into its furnaces than the application might indicate. Unfortunate for Salem-Brosius, but fortunate for you. Prices being equal, you, as a customer, can hardly lose from an extra measure of good design and sturdy construction that assures you greater production, longer life, and easier operation.

Take the case of the controlled-atmosphere small-parts hardening furnace shown here, for which Salem-Brosius is justifiably well-known. Users find that fast precise heating, complete atmosphere control, and rapid and high capacity materials handling mean better production. Why not take advantage of our bad habit of extra quality. Send us an inquiry for this or any other type of heat-treating furnace now.



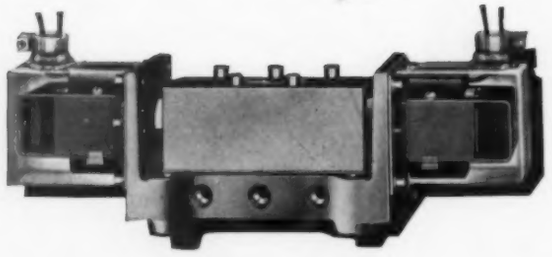
Controlled-atmosphere small-parts hardening furnace segment of a Salem-Brosius harden, quench and draw line.

SALEM-BROSIUS, INC.

Sales and Executive Offices: 248 Fourth Avenue, Pittsburgh 22, Pa.

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

FEATURE THIS MONTH

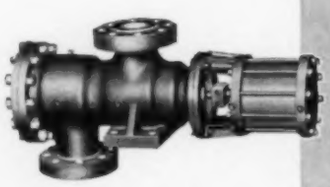


1/8" and 1/4" Double Solenoid Valves

Their reduced amperage requirement simplifies electrical circuits

● These valves are extremely simple in design — but ruggedly built — and will give millions of cycles of efficient, trouble-free, dependable operation. For air to 125 psi, vacuum, or low pressure hydraulic service. Up to 300 cycles a minute. Solenoid armature bears directly against the valve plunger eliminating levers, links, pins, etc. Low amperage requirement simplifies the electrical circuit. The valve is reversed by energizing first one solenoid, then the other. The valve and both solenoids are mounted on an aluminum base, and can be removed independently without disturbing the piping. 2-way, 3-way, double 2-way, 4-way and 5-way actions.

also the following

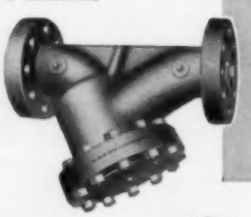


DESCALING VALVES

Specially designed for descaling hot strip and large steel forgings. Widely used. 2" to 6" sizes. Capacities to 1550 Gals./Min. Design eliminates destructive water hammer and reduces hydraulic shock to a minimum.

HIGH PRESSURE STRAINERS

Used ahead of descaling valves to prevent foreign material from plugging spray nozzles causing scale streaks in strip—also in hydraulic lines to protect valves, cylinders, and other machinery. 1½" to 6" sizes. Highly efficient. Easily cleaned.



For Fully Descriptive Data Sheets Write

C. B. HUNT & SON, Inc.

Hand, Foot, Lever, Cam, Pilot, Diaphragm and Solenoid Control Valves

1924 EAST PERSHING STREET • SALEM, OHIO

(*Continued from page 224*)

try, was electrical and mechanical superintendent of Republic Steel Corp., Massillon, Ohio, until his retirement a few years ago. He also worked for Jones and Laughlin Steel Corp., Pittsburgh, Pa., Crucible Steel Co. of America, Midland, Pa., Donner Steel Co., Buffalo, N. Y., and for predecessors of Republic in Massillon.

Stevenson Findlater, assistant to president of United States Steel Corp.'s National Tube Division, died from injuries received when hit by an automobile November 20. Mr. Findlater, first joined U. S. Steel at the National Tube Division's Ellwood City, Pa., Works as an apprentice engineer. He was transferred to the Pittsburgh general office in October 1929 as a seamless pipe engineer in the operating department. He was promoted to superintendent of the seamless pipe mills at the company's National Works, McKeesport, Pa., on January 1, 1930, returning to the Pittsburgh offices in 1936 as a process development engineer. On December 1, 1943, he was appointed assistant to the president.

Lewis William Mesta, 64, executive vice president of Mesta Machine Co., died December 30. Mr. Mesta

LEWIS WILLIAM MESTA

had been associated for 45 years with the Pittsburgh, Pa., industrial firm founded by his uncle, George Mesta, in 1898.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

Publication Service...

JANUARY, 1954

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Space Heater

Case Study No. 560-56, recently issued describes how a metal fabricating shop saved two-thirds the cost of a conventional heating system by using oil-fired, warm-air space heaters. The four-page folder explains the reason for the saving, the economics of operation, and the amount of floor space recovered for manufacturing after an old complicated system was replaced by the warm-air heaters. Dravo Corp.

(2) Electric Truck

Big truck advantages at small truck cost are promised in a new bulletin. Described and illustrated in this four-page folder is the telescopic high-lift platform truck which is available in capacities of 3000 and 4000 lb. Features of the truck as described in the bulletin include elevated platform heights up to 123 in. with a twin hoist motor and pump for fast lifting speed. Other features include roller mounted channels and platform for reducing friction and assuring smooth lifting and lowering. A 16 in. diameter turntable with 105 ball bearing and tapered roller support bearing assures operator ease in steering in tight quarters and narrow aisles. Included in the bulletin are drawings giving specifications as well as tables of dimensions. (P1512B) Yale & Towne Manufacturing Co.

(3) Bonding Aluminum Process

The complete story of the many successful applications of alumibonding is described in an eight-page fully illustrated booklet. This patented process of molecular bonding of aluminum and its alloys to iron, steel and their alloys is being used extensively in hundreds of applications where weight reduction is an important requirement. Other advantages include greater free machinability, corrosion resistance, and better thermal conductivity. Since pure aluminum has approximately five times the thermal conductivity of steel, heat dissipation is an important application. Of particular interest to design and production engineers, the booklet describes how superior bearings are obtained through the coupling of the well-known bearing qualities of aluminum (sometimes alloyed with tin, nickel and copper) to the strength, resilience and fatigue resistance of steel. Alumibond coating of steel has proved to be outstanding in resisting oxidation at high temperatures. Indications are that aluminum-clad cast iron or steel pistons will greatly reduce maintenance costs and improve performance of heavy duty diesel and gas engines. Arthur Tickle Engineering Works.

(4) Ceramics Chart

A new property chart has recently been released to guide the designer in the selection of material most adaptable to his requirements. In addition to the principle uses for steatites, alumina, cordierite, porcelain and lava, the chart gives a complete analysis of these materials detailing the following properties: water absorption, specific gravity, density, color, hardness, tensile strength, compressive strength, fexural strength, softening temperature, linear coefficient of thermal expansion 25 C-100 C and 25 C-600 C, Te value, dielectric strength (step 60 cycles), dielectric constant, power factor, loss factor. This table enables the designer to specify the grade of material required when ordering insulators, permitting the most advantageous application. M. Kirchberger & Co.

(5) Signal Transmitter

A bulletin recently issued illustrates and describes a heavy-duty pneumatic signal transmitter for use in measuring, indicating and controlling fluid flow and liquid level at operating pressures up to 1500 psi and pressure differentials up to 100 psi for steam generation and process control. Featured in the eight-page booklet are (1) design details which give the transmitter a linear-flow characteristic to eliminate the need of additional square root extractors in the totalizing equipment; (2) construction details of the several differential elements available; (3) simplicity of calibration, either under full static conditions or atmospheric pressure; (4) advantages of being able to operate without sealing fluids, a characteristic of vital importance where contamination is a problem; (5) economy in operating-air consumption, which averages about one-half cubic foot per minute. Also included are application sketches and explanations. (2553) Hagan Corp.

(6) Bronze Types

A 12-page bulletin with 35 tables, charts and illustrations presents a family of low shrinkage, heat treatable bronzes for machine component pressure and bearing castings that develop excellent mechanical properties in the "as cast" condition. It describes a relatively simple heat treatment that can increase as-cast strengths 30 to 60 per cent, culminating in the 90,000 psi range. They are shown to be economical, fine grained, pressure tight and versatile. Typical compositions and applications are given. (A107-8) International Nickel Co.

(7) A-C Motor Frame Selection

A selection wall-chart which shows the comparison between "old" and "new" NEMA standard dimensions for a-c motors from 1 to 30 hp is available. The chart is meant to provide a handy reference for determining differences in frame dimensions. New and old dimensions for polyphase squirrel-cage, polyphase wound-rotor, and single-phase, foot-mounted motors are presented as well as separate dimensions for flange-mounted motors. Dimensions for drip-proof and totally-enclosed, fan-cooled motors are also given. The chart, which measures 18 x 24-inches,

gives old dimensions in blue, new dimensions in red, one immediately above the other, so that differences can be detected at a glance. Westinghouse Electric Corp.

(8) Elevated Temperature Corrosion

Because of the increasing interest in higher operating temperatures and pressures for greater efficiency of chemical and metallurgical processes, reprints are now available of a paper presented by Dr. F. H. Beck and Dr. M. G. Fontana, Ohio State University, at the Ninth Annual Conference of the National Association of Corrosion Engineers. Entitled "Corrosion by Aqueous Solutions at Elevated Temperatures and Pressures," the paper is a result of a continuing study of corrosion under ACI sponsorship. High temperatures and pressures have created a problem of developing materials of construction that can withstand these new conditions. In the Ohio State project, one of many designed by ACI technical committees to develop improved alloys, Dr. Beck and Dr. Fontana are investigating commonly used alloys of the 18-8 variety (CF-8 and CF-8M) and high nickel grades in a variety of corrodents. Modifications of these alloys will be studied to develop improved corrosion resistance and methods for inhibiting corrosive attack. The paper deals with preliminary results which suggest the possibility of utilizing minute amounts of inhibiting agents in chemical fluids. Alloy Casting Institute.

(9) Duradiant Soldering Furnaces

A bulletin now available describes a new soldering iron furnace capable of heating two four-pound irons from room temperature to 900 F or one iron to 1200 F in less than eight minutes, with a heat input of only 9100 Btu per hour. Flame impingement on the coppers is eliminated, avoiding oxidation and burning of the copper, which retains a bright, tinned working surface over a greatly lengthened life. The burner is located so that damages from mechanical shock and flux corrosion are negligible. Refractory hearth is easily removed for cleaning and a die-pressed furnace lining is quickly installed if replacement is ever necessary. Furnace casing temperature is low because of the efficiency of the insulating lining, and the low heat input. A tilted shelf keeps much of the excess heat from being directed toward the operator. (Bulletin SC-1038) Selas Corp.

(10) Industrial Spray Nozzle

A complete spray nozzle reference catalog has been published. Thousands of standard and special industrial spray nozzles are illustrated and described. For each nozzle, complete data is listed covering capacity and spray angle. Dimensional specifications for all standard nozzles are also given. Because the information is so extensive, a new type of index was designed to assist the reader in finding desired data. Spray nozzles are indexed in terms of "Spray Patterns." The six main headings are "Hollow Cone, Full Cone, Square Spray, Flat Spray, Straight Stream and Air Atomizing." In addition to spray nozzles, information is supplied on a wide variety of related equipment such as line strainers, elbows, check valves, and adjustable joints. For handy use by the engineer, tables are included on spray coverage and pipe frictions. (Catalog 24) Spraying Systems Co.

(11) High Production Batch Furnace

A new bulletin on the ALLCASE batch type controlled atmosphere furnace has just been released. It is a six-page illustrated folder that completely describes the features of the standard and heavy duty sizes of this radiant tube heated furnace. Equipped with a recirculating fan and an enclosed quench it can be used for all types of controlled atmosphere steel treatments. Included in this bulletin are detailed construction drawings and photographs of typical process applications. (Bulletin SC-163) Surface Combustion Corp.

(12) Power Shears

A new highly-illustrated catalog covering Steelweld pivoted-blade power shears, has just been completed. Dimensions and specifications are given for 31 different sizes of shears in the regular line, ranging from 6 ft x 10 gage to 12 ft x 1 in. capacity. Larger Steelweld shears have been built, however, for cutting steel to 24 ft by ¼ in. (Catalog 2011-E) The Cleveland Crane and Engineering Co.

(13) Utility Heaters

A new bulletin on utility unit heaters has been published. These are lightweight, horizontal discharge heaters for general purpose heating, embodying the well-known "Featherfin" heating element with finned tubes of seamless drawn copper. The fan, in many sizes of this heater, features a new type of motor mounting, incorporating an integral safety guard. Engineering data, with wiring and piping details are also included in the bulletin. L. J. Wing Manufacturing Co.

(14) Plant Modernization

A new brochure has been published to help guide company management and engineers in dealing with the complex problems of modernizing and expanding plant facilities. The publication outlines a detailed step by step procedure for analyzing existing plant facilities to establish the type, quantity and value of products which should be manufactured; type, number and cost of tools, equipment and machinery required; and size, location and cost of floor space needed for projected modernized or expanded plant and production facilities. A section on "Organizing the Planning Program" establishes four basic steps: (1) determination of production quotas; (2) analysis of products and product components; (3) analysis of production facilities; and (4) preparation of optimum layout. A separate section is then devoted to each of these steps. Specific data that each company department must submit to top management and how this data should be evaluated to arrive at specific management decisions are indicated in each section. Walter Kidde Constructors, Inc.

(15) General Catalog

A new 1954 general catalog provides an outstanding treatise on rust prevention and is dedicated to showing all industry how to stop rust. The new, enlarged catalog includes complete instructions for surface preparation and application of primers, short oil type, long oil type, machinery and implement finishes, chemical and heat resistant types, sealers, oil field finishes, thinning oils, and floor and masonry coatings. Among the new products described in the 1954 general catalog are the new restful color group of finishes developed to provide new color harmonies for plant interiors and machinery surfaces; oil field finishes, especially prepared to match original manufacturers' colors and resist extreme rust-producing conditions of the oil fields; and the exclusive, extra-long-nap lamb's wool roller that reaches around wire fences to coat

approximately 70 per cent of the other side at the same time, making up to 40 per cent savings possible. Rust-Oleum Corp.

(16) Conveyor Chain

An eight-page folder, devoted to alloy cast steel conveyor chain, has been released. It is of particular value to users of industrial chain in that it contains complete specification information for the types of chain most adaptable to present day requirements. Farrell-Cheek Steel Co.

(17) Bending, Straightening and Plate Forming Presses

A comprehensive 16-page catalog now available, covers a wide variety of presses for bending and straightening applications, the new booklet is sectionalized for ease of reference. Gap type models, traveling head models, column and side plate units and special designs are individually presented with illustrations and descriptions of typical models. Lake Erie Engineering Corp.

(18) Abrasive Snagging Wheels

A new 12-page catalog brochure, has been issued containing the latest grinding wheel recommendations for various materials, including titanium alloy, and data about patented flanges built into the grinding wheel to provide a steel against steel fit with the mounting flanges. (Form ESA-62) Simonds Abrasive Co.

(19) Bronze Electrode Welding

A new 24-page bulletin, recently issued, describes the complete line of products for use with metal-arc, carbon-arc, inert-gas tungsten-arc, submerged-arc and inert-gas consumable electrode processes. Included is a wealth of valuable up-to-date technical information and data relative to welding with bronze electrodes and filler rods. The data contained in this bulletin should prove invaluable to the welding engineer, design engineer, welding supervisor and welding operator as a reference book on bronze electrode and filler rod usage. (Bulletin W-17) Ampco Metal, Inc.

(20) Small Rolling Mills

An eight-page, two-color bulletin illustrating a complete line of low-cost, precision-built laboratory and production rolling mills has been issued. Construction features of the rolling mills and the reasons for their superior performance are described. The booklet shows how engineers incorporate into the mills advanced engineering features formerly associated only with the heaviest type of rolling mill equipment. Through the use of standardized interchangeable parts, these versatile, rugged units meet the special requirements of smaller manufacturers. Stanat Manufacturing Co.

(21) Open Hearth Stack Gas Cleaning

A new bulletin with conveniently arranged information for a quick understanding of the special design features of electrostatic precipitators for open-hearth steelmaking applications has been announced. The electrostatic method which offers high dust collection efficiencies in cleaning open hearth stack gases at normal operating and maintenance costs is explained in the new bulletin. Diagram and cut-away view of the equipment show operating and construction details. Research Corp.

(22) Wire Rope Slings

A new folder describes the new line of Red-Strand multiple part slings and pin-lock thimbles, explaining how these thimbles reduce sling costs by an average of 20 per cent. The folder also describes new single-part slings equipped with single-swaged fittings. Leschen Wire Rope Division, H. K. Porten, Inc.

(23) Industrial Cranes

A new 24-page bulletin on industrial cranes has just been published. The new brochure is illustrated with photographs of a wide variety of interesting installations of industrial cranes. Explanatory diagrams and scenes showing different phases of crane production are also included. Complete specifications are also shown. (Bulletin C6-3) Harnischfeger Corp.

(24) HCB Single Stage Turbine

A six-page bulletin containing design features, dimensions and performance data on the new HCB single stage turbine has been issued. The stage turbine was designed for a variety of plant applications and can be ordered from stock for immediate delivery. Maximum operating conditions of the HCB turbine are: hp to 100, pressures to 300 psig, temp. to 550 F, speed to 4000. The bulletin presents a two-page cut-away diagram of the HCB turbine with a descriptive list of 18 design features. Length and width measurements and dimensions of parts are given in line drawings of the HCB turbine. Other information includes performance data and construction materials. (Bulletin 4206) De Laval Steam Turbine Co.

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AMERICAN BRAKE SHOE CO. AMERICAN MANGANESE STEEL DIVISION		Catalog sheet giving information on Amsco hard-facing electrodes.
51	AMERICAN CHEMICAL PAINT CO.	BULLETIN 13 AND DATA SHEET 13-1-1-4.	Booklets and chart on pickling.
52	AMERICAN FLEXIBLE COUPLING CO.	CATALOG 50.	Contains information on flexible couplings.
53	AMERICAN WHEELABRATOR & EQUIPMENT CORP.	BULLETIN 894.	Tells how to descale strip at high speeds and low cost.
54	BEDFORD FOUNDRY & MACHINE CO., INC.		Complete catalog describing Bedford cranes.
55	E. W. BLISS CO.		Complete rolling mill brochure.
56	BUSSMANN MANUFACTURING CO.		Contains facts about dual-element fuses.
57	CARBORUNDUM CO.		Describes steel deoxidizing.
58	CRANE CO.	FOLDER Ad1977.	Describes complete Crane line of valves for safe control of ammonia.
59	DOWELL INCORPORATED.		Booklet tells about chemical cleaning of steel mill equipment.
60	DREVER CO.	BULLETIN B-52.	Gives facts on their ammonia dissociator.
61	ELECTRIC MACHINERY MANUFACTURING CO.		Description of E-M 2-pole motor.
62	ELECTRIC SERVICE MANUFACTURING CO.		Illustrated folder available on industrial insulators.
63	FALK CORPORATION	BULLETIN 1104.	Describes straight line speed reducers.
64	FARREL-BIRMINGHAM CO., INC.	BULLETIN 273.	36-page bulletin on rolling mills.
65	FARVAL CORP.	BULLETIN 26.	Contains full information on centralized lubrication.
66	FOOTE BROS., GEAR AND MACHINE CORP.		Bulletin — Straight Line-O-Power Drives.
67	FOOTE BROS., GEAR AND MACHINE CORP.		Bulletin — New Foote Bros. Backstop.
68	FOOTE BROS., GEAR AND MACHINE CORP.		Bulletin — Right Angle Line-O-Power Drives.
69	FOXBORO CO.	DATA SHEET 330-12.	Electronic open hearth reversal control.
70	C. B. HUNT & SON, INC.		Descriptive data sheets on control valves.
71	IDEAL INDUSTRIES, INC.		Complete information on commutator maintenance.
72	INDUSTRIAL GEAR MANUFACTURING CO.	BULLETIN 152-A.	Describes industrial cut gears.
73	JOY MANUFACTURING CO.	BULLETIN MC106.	Contains information about plugs and receptacles for industry.
74	KAISER CHEMICALS		Literature on ramming materials and refractory brick.
75	McDANEL REFRACTORY PORCELAIN CO.		Bulletin on industrial porcelains.
76	MINNEAPOLIS-HONEYWELL REGULATOR CO.	DATA SHEET 4.3-4a.	Information on metered fuel-air ratio control.
77	MORGAN ENGINEERING CO.	BULLETIN 32-A.	Contains complete information on soaking pit cranes.
78	NATIONAL CARBON CO.	CATALOG S-6210.	Information on carbon brick for maintenance.
79	OKONITE CO.	BULLETIN IS-1053.	Literature showing performance of Okolite-Okoprene cables.
80	PITTSBURGH LECTROMELT FURNACE CORP.	CATALOG 9.	Gives complete data on Lectromelt furnaces.
81	PLASTEEL PRODUCTS CORP.		Engineers' handbook for use of Plasteel products.
82	POST-GLOVER ELECTRIC CO.	BULLETIN 410, DEPT. E.	Bulletin describing master switches.
83	PYLE-NATIONAL CO.	BULLETIN 5015.	Gyralite warning signals for safety.
84	RUST-OLEUM CORP.		Literature about Rust-Oleum.
85	U. S. GRAPHITE CO.		Catalog describing USG brushes for electrical machines.
86	WAGNER ELECTRIC CORP.	CATALOG IU-36.	Full description of powered hydraulic braking.
87	WAGNER ELECTRIC CORP.	CATALOG IU-40.	Information about replacement linings and brake wheels.
88	WALKER PROCESS EQUIPMENT, INC.	BULLETIN 10169.	Contains information on thickeners for flue dust recovery.

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pioneering developments keep WHEELABRATOR® first in blast cleaning

Steel Strip Descaled without Scale Breaking

More uniform, better quality strip at lower cost with Wheelabrator mechanical cleaning

Advantages of Airless Wheelabrator mechanical cleaning at Washington Steel Corp. in removing scale from stainless steel strip is summarized by Mr. T. A. Fitch, President, as follows: "The Wheelabrator makes short work of the heavy scale with none of the rolled-in scale, coil digs, slivers, etc. so common to cold-rolled methods of scale breaking. It is faster, more efficient, and does a better job quality-wise."

Prior to the installation of the Wheelabrator in its strand annealing and pickling line, Washington bought annealed and pickled coils for cold rolling and finishing. With the Wheelabrator they are obtaining better quality descaling at production line speeds plus a reduction in manpower and reduced use of pickling acid.

Mechanical descaling of steel strip with the Wheelabrator as an integral unit in steel cleaning lines is also returning impressive savings for other steel producers and fabricators alike. Rome Cable Corp., for example, selected Wheelabrating for descaling steel strip because it was the only process that would economically remove surface scale and permit the rest of the plant to maintain its high production without requiring a major portion of its plant area.

Wherever steel is processed in large quantities, the possibilities for saving money with a Wheelabrator are tremendous. Write today for full details.

Bulletin 894 tells how to descale steel strip at high speeds and low cost. Send for your copy today.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Ind.

Wheelabrator®
AIRLESS BLAST CLEANING

for Carbon and Sulphur Determinations

Precision made in every detail, McDanel High Temperature Porcelain Combustion Tubes have been favorites in America's metallurgical laboratories since 1919. Made of a highly refractory porcelain body and recommended for 2900°F. service, McDanel Tubes give maximum resistance to thermal shock. Their long life keeps control costs at rock bottom.

Refractory Porcelain Specialties in stock or designed to meet specific needs. Flasks, retorts, crucibles, etc. and parts "custom-made" to do the job.

Write Today for Catalog
"McDanel Industrial Porcelains"

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BEAVER FALLS, PENNA.

GYRALITES
WARN FOR SAFETY . . .

Type 15100 Gyralite for low voltage duty. With rotating glass reflector.

with high intensity rotating light beams

The Gyralite projects a beam which rotates with a wide, circular sweeping action...every eye within range of danger sees and PINPOINTS the safety hazard instantly!

Compact and reliable Gyralites solve your warning signal problem when noise levels are too high for sound signals or where multiplicity of sound signals would confuse. Gyralites install easily on overhead cranes and other hazardous moving equipment. Portable Gyralites protect ground crews at hazardous locations. Automatic control by time switch, pressure switch, float switch or electric eye will safeguard equipment and personnel in innumerable plant operations.

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PYLET CONDUIT FITTINGS · FLOODLIGHTS · PLUGS & RECEPTACLES

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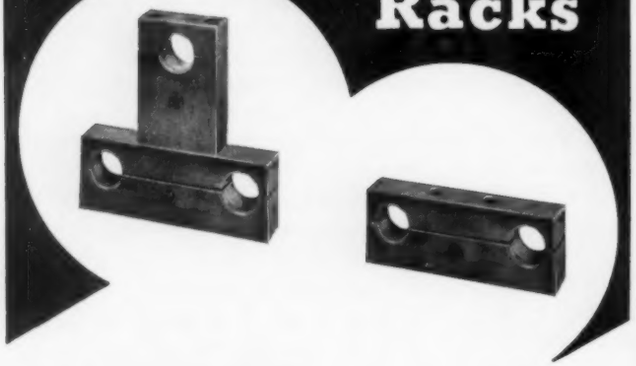

fabricated of all-insulating "Sali" material
extra strong—really rugged!

Wide range of standards. Modifications and specials easily available.

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Superior
BLAST FURNACE COPPER CASTINGS

Cooling Plates of all kinds including Heavy Nose Super Cooled Bosh Plates.
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Blast Furnace Copper Castings—also Brass and Bronze Mill Castings

for heat treating bars and tubes

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SAVES SPACE

Heating bars in a furnace one-third shorter than the length of the bar itself is typical of Selas *Improved Heat Processing.* One company using a 14-foot high-speed radiant, gas-fired furnace doubled its previous output rate in tons per hour of 22-foot bars.

Selas **ihp*** is in use for bars and tubes of stainless, carbon, or alloy steel and non-ferrous metals . . . for hardening, drawing, normalizing and annealing. Treating metals at mill production speeds, *Improved Heat Processing* methods save furnace and storage space, plus many dollars in handling costs.

Every bar is given the same uniform treatment, resulting in consistent metallurgical results not only from end to end of any one bar, but also from bar to bar.

Numerous magazine articles attest to the efficiency of Selas methods. Ask for printed material describing results obtained by companies with problems similar to yours.

Improved Heat Processing

SELAS

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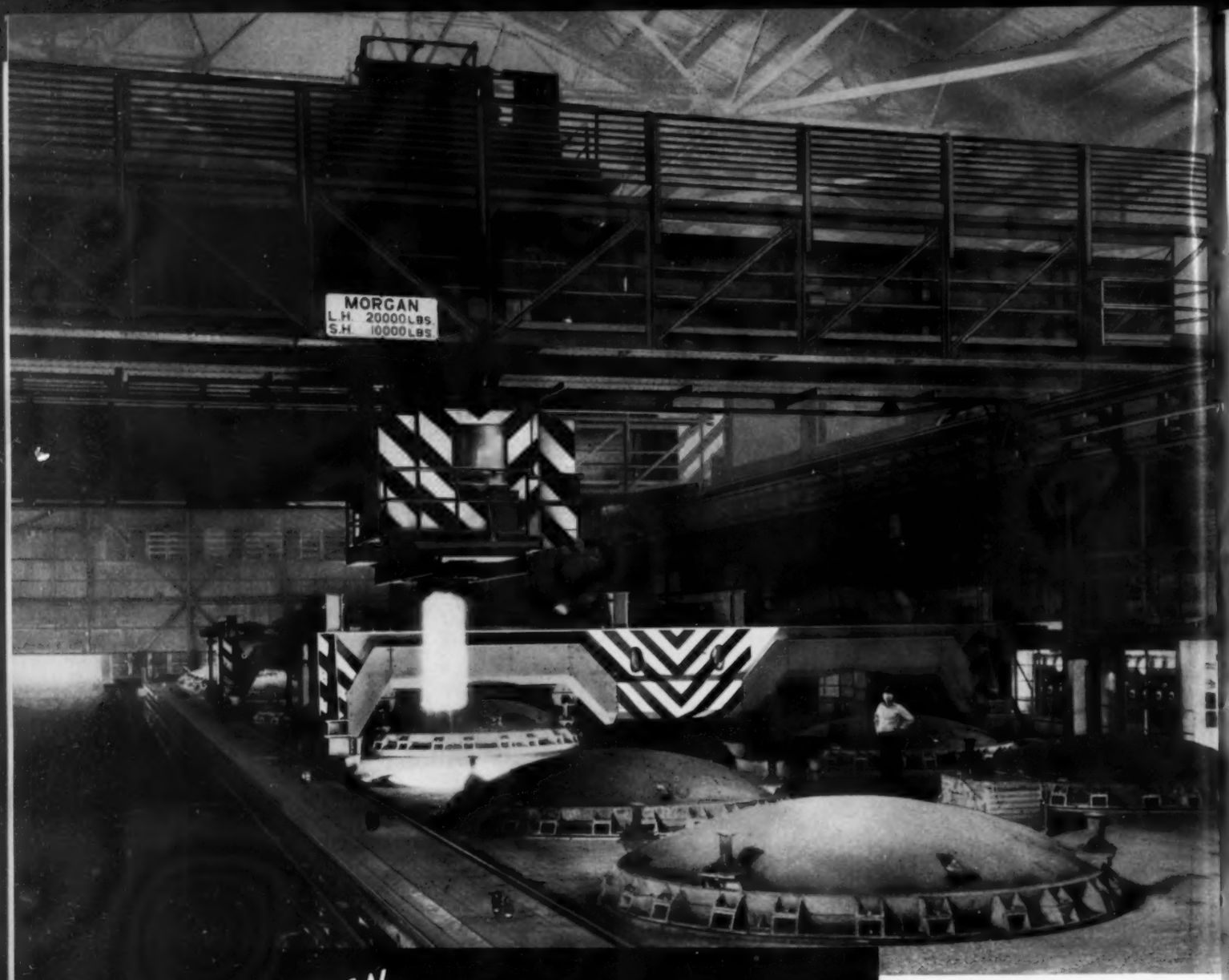
Heat Processing Engineers for Industry — Development • Design • Manufacture



BUILT BY MORGAN *Engineering*

MORGAN CRANES AT PUEBLO

Illustrated is one of two Morgan 10-ton, 7-motor, 94'5" span Soaking Pit Cranes at The Colorado Fuel & Iron Corporation's Pueblo Works. These cranes have a tongs range of 15"-30". All motions on trolley are through worm reduction units. The trolley frame, bridge trucks and ram are fabricated and welded into one-piece units.

Morgan has followed very closely the development of soaking pit cranes from the first tower and rack type to the present modern low stiff leg type built with or without counter-weights. Send for Bulletin 32-A.

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- SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN *Engineering* CO.

ALLIANCE, OHIO • PITTSBURGH — 1420 OLIVER BUILDING

Equipment News...

NOZZLE ADAPTER

▲ An extremely simple, inexpensive nozzle adapter for the conventional semi-automatic or "squirt" welder gives promise of a new and considerably wider use for this machine. The device makes possible the deposit of various alloys at speeds far higher than can be obtained by ordinary manual welding, even exceeds the deposition rate achieved by the full automatic electric welding head. In essence the process utilizes the magnetic field created by the passage of the electric current through the bare electrode, plus a magnetic alloy flux which coats the wire immediately ahead of the welding arc. The operating cycle is completed by the use of permanent magnets in the nozzle adapter which act as a dam to the flow of the flux whenever the arc is broken.

The whole process is merely a combination of two accepted and proven welding methods—the squirt welder which uses a granular non-magnetic flux to produce the common submerged melt deposit, and the magnetic flux method of automatic welding as perfected by Brown Boveri in Switzerland some years ago. The squirt welder, employing the hidden arc beneath a simple flux, is in everyday use and is familiar of course to all those interested in welding.

The Brown Boveri method is less widely recognized. Basically it depends upon use of the magnetic field surrounding the welding electrode in conjunction with a granular magnetic metallic flux.

Some time ago Stoody Co. became interested in magnetic flux as a possible method of applying alloy materials through semi-automatic welders, the use of which is limited to small diameter wires, generally $\frac{5}{64}$ and $\frac{3}{32}$-in., sizes too small to be fabricated into tubular wires such as this company furnishes for application through the full automatic head. The Brown Boveri method, as adapted to the squirt welder and tested over a considerable period, appears to offer numerous advantages over both manual and present semi-automatic welding. As applied to build-up and hard-facing, the magnetic process provides much higher deposition rates (8 to 20 lb of deposited metal per hour, using $\frac{5}{64}$-in. of $\frac{3}{32}$-in. wires); the deposition rate will depend upon amperage. Deposits are sound, with the consistency and uniformity characteristic of the automatic welding method. Time lost in changing electrodes is eliminated and there is of course no stub-end loss.

By comparison with the semi-automatic hard-facing method utilizing an alloy submerged melt flux, the magnetic process eliminates considerable waste, since all the flux applied to the wire is consumed. This feature also makes unnecessary flux recovery equipment and screening for re-use.

Stoody Co. has developed a series of magnetic flux materials designed for both build-up and the application of hard-facing overlays.

FIREBRICK

▲ Increased checker chamber efficiency and elimination of hot metal splash build-up are two advantages reported for insulating firebrick in actual use in Pittsburgh district.

According to Zonolite Co., Chicago, Ill., producers of the vermiculite insulating firebrick, checker chamber efficiency for a major producer is increased from five to ten per cent because of the product's low heat absorbing capacity, which confines heat within the chamber.

Used on stationary mixer sidewalls and in other areas where steel splashes may accumulate, the firebrick's smoothness and lightness prevents splashes from sticking and building up.

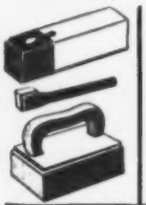
A fired ceramic product made of fine-grain vermiculite clay, the firebrick possesses great mechanical strength as well as uniform density.

Contributing to the five to ten per cent increase in checker chamber efficiency are these specific factors made possible by Zonolite firebrick:

1. Higher checker temperatures and more efficient checker operation.
2. Lowered fuel costs.
3. Reduced maintenance ordinarily required to gun on insulating and sealing cements.

Firebrick (light color) applied to open hearth checker chamber bulk-head door both seals and insulates, increasing checker chamber efficiency from five to ten per cent. The firebrick forms outside stretcher course only, the remainder of the door being ordinary firebrick.

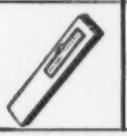
Keeps motors running like new... The easy, fast way to restore commutators and slip rings — WITHOUT DISMANTLING! — Substitutes low-cost prevention and correction for high-cost repair and rebuilding — COSTS LITTLE, SAVES A LOT.



RESURFACERS
Refinish commutators and rings to like-new condition even when ridged, scored or burned.

MICA UNDERCUTTERS
Stop sparking — help commutation — prolong brush life. For all sizes of commutators.

PRECISION GRINDERS
For more than surface smoothing—under machine's own power. Accurate to .001".



FLEXIBLE ABRASIVE
Cleans and burnishes commutators. Non-dusting. Complete size range.

FREE 39-page Handbook — Complete information on commutator maintenance. MAIL COUPON.

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NAME_____
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TITLE_____
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For use in either hot or cold metal shops, the brick forms the outside checker chamber stretcher course, with the balance of the wall made of usual fireclay brick.

Because of its great strength, the brick can be re-used if it is the practice to tear out any portion of the checker chambers at frequent intervals. For this reason, the brick is laid up dry or with heat setting mortar.

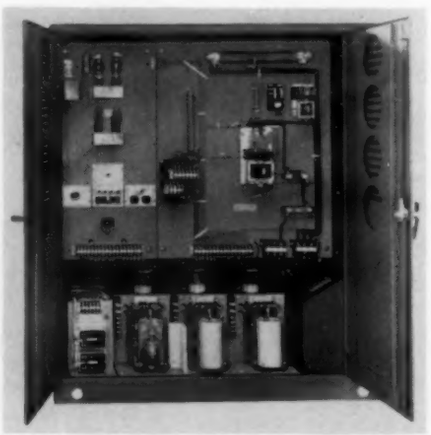
Its uniform density and low heat absorbing capacity enable Zonolite brick to seal as well as insulate. There is less infiltration of cold air due to expansion and contraction of the brick, as is common with firebrick.

To reduce infiltration to a minimum, one major user sprays the Zonolite brick with a ⅛-in. coat of fireclay sealer, finished with a ⅛-in. coat of vermiculite cement.

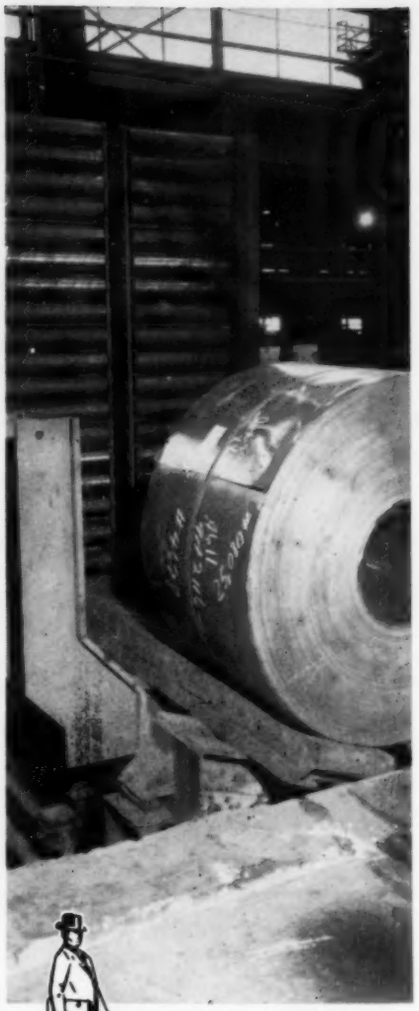
With or without this treatment, use of Zonolite brick eliminates the gunning on of thick layers of insulating and sealing cements, which usually fall or flake off because of escaping heat, presenting a constant maintenance problem.

POWER DRIVE

▲ Development of a new mercury rectifier variable-voltage power drive designed for a broad range of industrial applications requiring adjustable-speed service is announced by the Reliance Electric & Engineering Co., Cleveland, Ohio, pioneer producer of packaged, all electric motor-drive systems.



The new pre-engineered drive, identified as the "Reliance Xatron V*S Drive," represents the result of four years' intensive design research and engineering exploration. Utilizing mercury arc rectification with a newly developed single anode mer-



THE MATHEWS ENGINEER BRINGS YOU 47 YEARS OF EXPERIENCE IN MECHANIZED HANDLING

Modern conveyer system work is a highly-specialized field . . . one in which there is no substitute for experience.

When you consult the Mathews engineer you get the benefit of experience, plus engineering resources and production facilities of three modern plants.

To get a greater return on your conveyer investment, better design, more efficient performance, longer service, call your nearest Mathews representative. Write for complete information.

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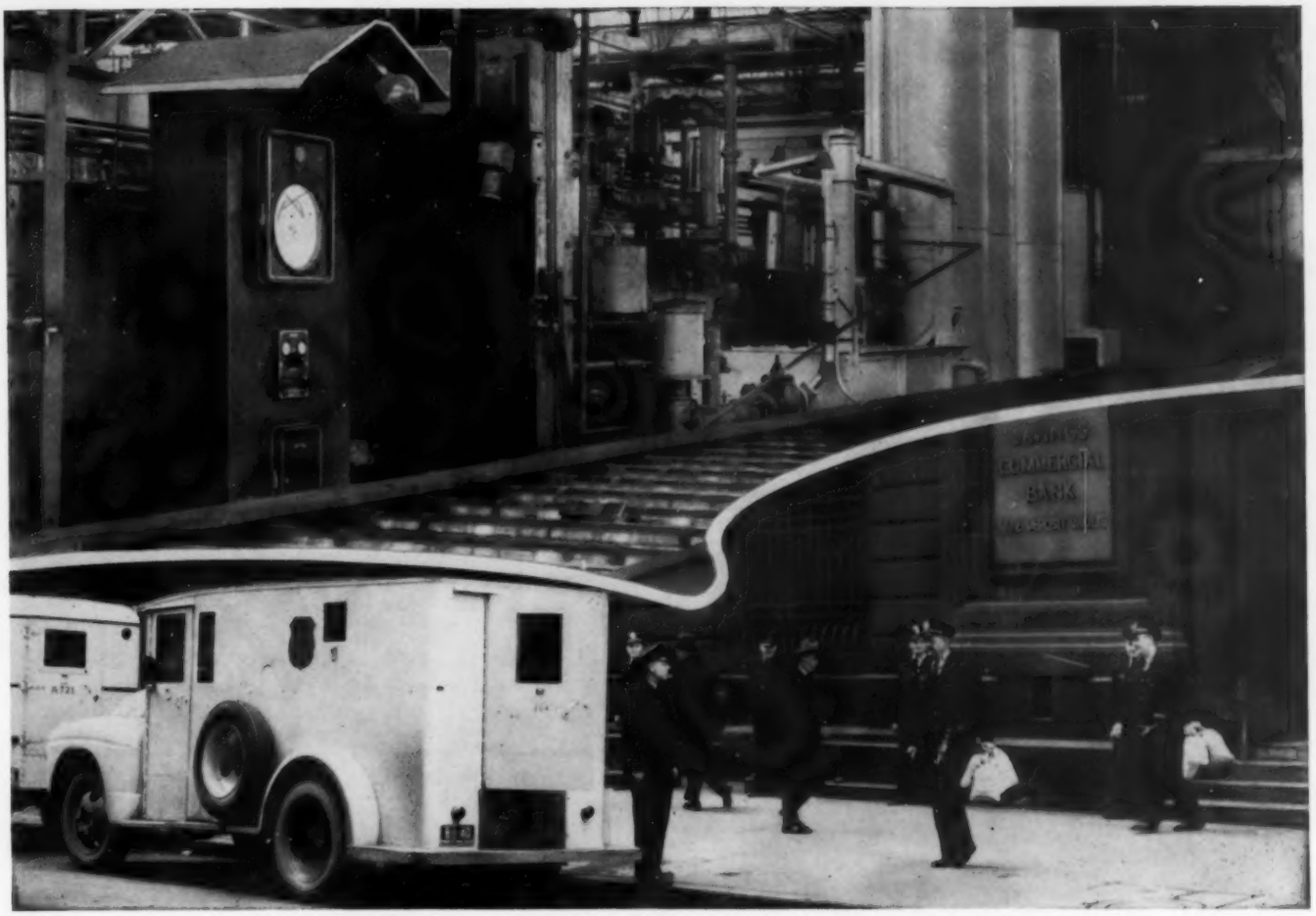


Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

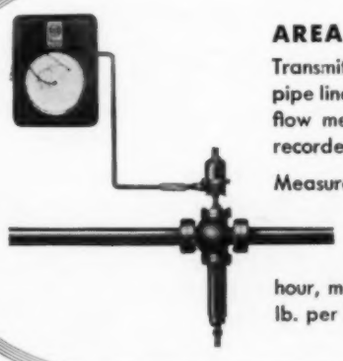
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials. P-26



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 9600 lb. per hour.

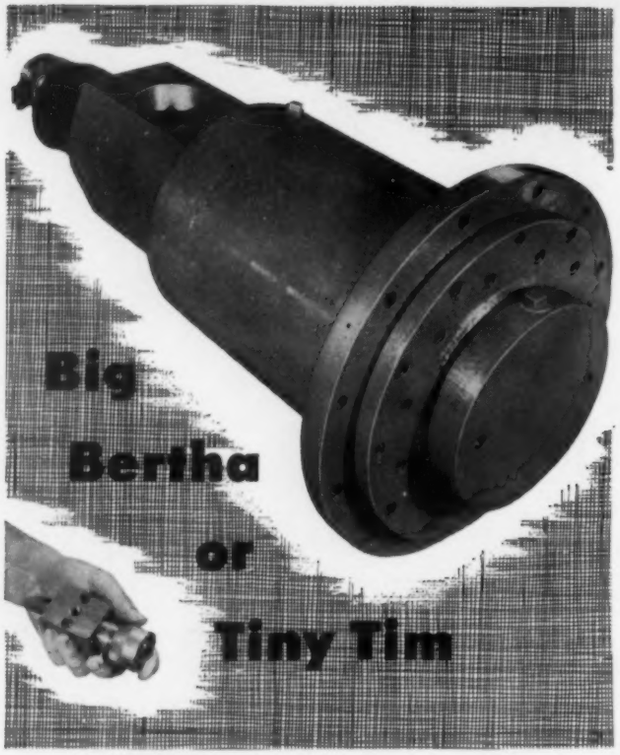
BAILEY METERS

BAILEY METER COMPANY

1047 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO



Your Anker-Holth cylinder matches your job

Sure, these power cylinders are unusual. The big one has an 18-inch bore and 19-inch stroke, and handles 2000 p.s.i. hydraulic pressure! The little one has a 1-inch bore and is for air power. But both are all in a day's experience of the nearby Anker-Holth engineer who is available to help you solve problems in power motion. To be sure you get the *right* air or hydraulic cylinder for *your* specific job, *specify* Anker-Holth and ask for our engineering help. Call or write Anker-Holth Division of The Wellman Engineering Company, Dept. E-6, 2723 Conner St., Port Huron, Michigan.

FREE *on request . . . bulletin on complete line of Anker-Holth products.*

Anker-Holth
ENGINEERED CYLINDER POWER
WELLMAN

Division of
THE WELLMAN ENGINEERING COMPANY

ONE MAN HANDLES IT EASILY

FARNCO
ALL ALUMINUM CONVEYOR

Built to reach inaccessible places, carries brick, sand, flu dust, wet concrete. Can be used in multiple units for long hauls.

POWERED BY AIR GAS or ELECTRIC

Built of **STRONGEST, TOUGHEST,** aluminum
Designed and manufactured by precision engineers who specialize in close tolerances. **SAVES MANPOWER SAVES $ $**

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cury pool rectifier tube known as an "Xatron," it now gives industry another way to convert alternating current to controlled d-c variable voltage for application to adjustable-speed drive equipment.

The first size of air-cooled Xatron rectifier available, operating in a three-phase bridge arrangement, provides conversion suitable for 30, 40 and 50-hp drives. It is also expected to find uses in several other fields besides voltage-controlled drives.

Supplementing the adjustable-speed drive equipment made by the company during the past 14 years, the Reliance V*S Drive with Xatron consists of (1) the operator's control station, (2) the adjustable-speed drive motor, and (3) the control unit, which is conveniently enclosed in a compact cabinet 56⅝-in. wide, 65¾-in. high, and 28-in. deep.

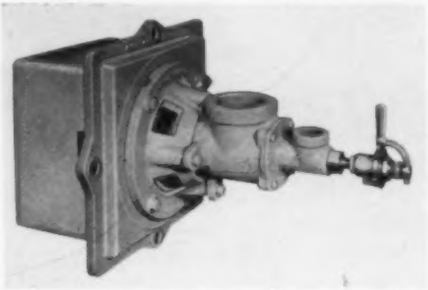
The control units are substantially lighter in weight — and for 40 and 50-hp drives smaller in size—than control units including rotation conversion equipment. Use of the multiphase bridge circuit makes possible the regular use of drive motors of the same physical size as used with rotating conversion.

Offering a dependable, efficient, controlled source of direct current variable-voltage by rectification of three-phase alternating current power for on-the-spot conversion at the point of application, the control unit provides the full range of flexibility and other important operational advantages of d-c motor-drive without the necessity for a d-c distribution system and a central a-c to d-c converting installation. Selection and regulation of desired rates of speed —and at desired rates of acceleration where this function is essential to operation of production equipment—are obtained by utilizing the controllable output of the individually-driven machine.

Control unit of this Reliance mercury rectifier adjustable-speed drive incorporates six Reliance-developed single anode, air-cooled mercury tubes. Each Xatron is arranged as a unit with its respective saturable reactors, magnet, and exciting bank, and is well-shielded. Operating from a three-phase power supply with a full-wave bridge to give a six peak d-c output, the tubes are grid controlled by an electronic phase-shifting circuit. Assembled as a unit mounted on a base, which also serves as an air-pressure chamber for a blower supplying filtered cooling air, they are pre-wired, interconnected back-to-back and three on a side, and arranged in individual L-shaped panels located over the air chamber.

BURNERS

▲ The North American Mfg. Co., has filled a gap in its popular line of Series 212 dual-fuel burners by adding recently the 212-5 size (2½-in. air connection). Like all Series 212 burners, the 212-5 is a rugged burner



which will withstand abuse, making it a "natural" for use on forge furnaces. It also finds application on melting pots, driers, and kilns.

These burners may be operated on heavy oil, light oil, or gas; with either manual or automatic control. Low pressure air is used for oil atomization; the pressure requirements at the burner being 22 osi for heavy oil and 14 osi for distillate oil.

Capacity of the 212-5, when operating on gas with combustion air pressure of 16 osi at the burner, is 925,000 Btu per hour. Capacity when operating on oil is increased to 1,200,000 or 1,350,000 Btu per hour because of the additional air supplied for oil atomization. The 212-5 has good turndown, since even on heavy oil it can operate on atomizing air only without forming carbon.

CLUTCH REEL

▲ A new type medium size wire and stock reel designed with a four in. oscillating movement is now being manufactured by the A. H. Nilson Machine Co. The oscillating feature reduces the load on the feed mechanism of the machine and, by means of a limit switch, automatically stops the machine in case of wire entanglement on the reel.

Used with medium size wire coils,

the new clutch reel is specially useful in shops where one operator handles more than one machine. A spiral spring holds back the coil which is

suspended and pivoted to a vertical shaft. The oscillating movement compensates for pulls on the stock thereby reducing the load on the feed and prevents stock slippage. Overtravel of the reel beyond the oscillating movement will automatically stop the machine through use of a limit switch.

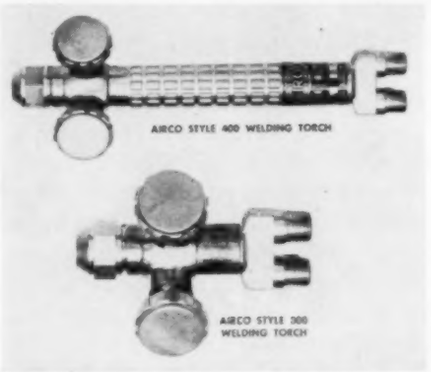
The reel is furnished in two sizes. The Model 51-L has a coil capacity of 175 lb and an 8-in. minimum inside diameter. The Model 51-M has a 250 lb coil capacity and a 12-in. minimum inside diameter.

WELDING TORCH

▲ Two new Air Reduction torches are now available to industry, the style 400 and the style 300.

The Airco 400 is especially designed for light welding and brazing operations such as automobile bodies, airplane fuselages, kitchen utensils, metal furniture and a host of other light fabrication and repair applications. The Airco 400 is 5¾-in. in length and weighs but six ounces. A corn-cob handle assures a firm, steady grip. A cutting attachment is available for this torch which quickly adapts it for occasional cutting jobs.

The Airco Style 30.0 is a compact, lightweight torch designed primarily for oxyacetylene burning or welding of lead products—sheet, pipe and storage battery parts. It is also suited for jewelry repair work, automobile radiator soldering and light production welding. This torch weighs 5 oz and is 2½-in. in length.



Both torches have ball-type oxygen and acetylene valves which are positioned for easy thumb adjustment and a variety of tips, mixers and extensions are available for these torches.

VACUUM HANDLE

▲ The safety tool division of Ampco Metal, Inc., Milwaukee, Wisc. announces the analysis and functions of a vacuum grip handle as a stand-

(*Please turn to page 250*)

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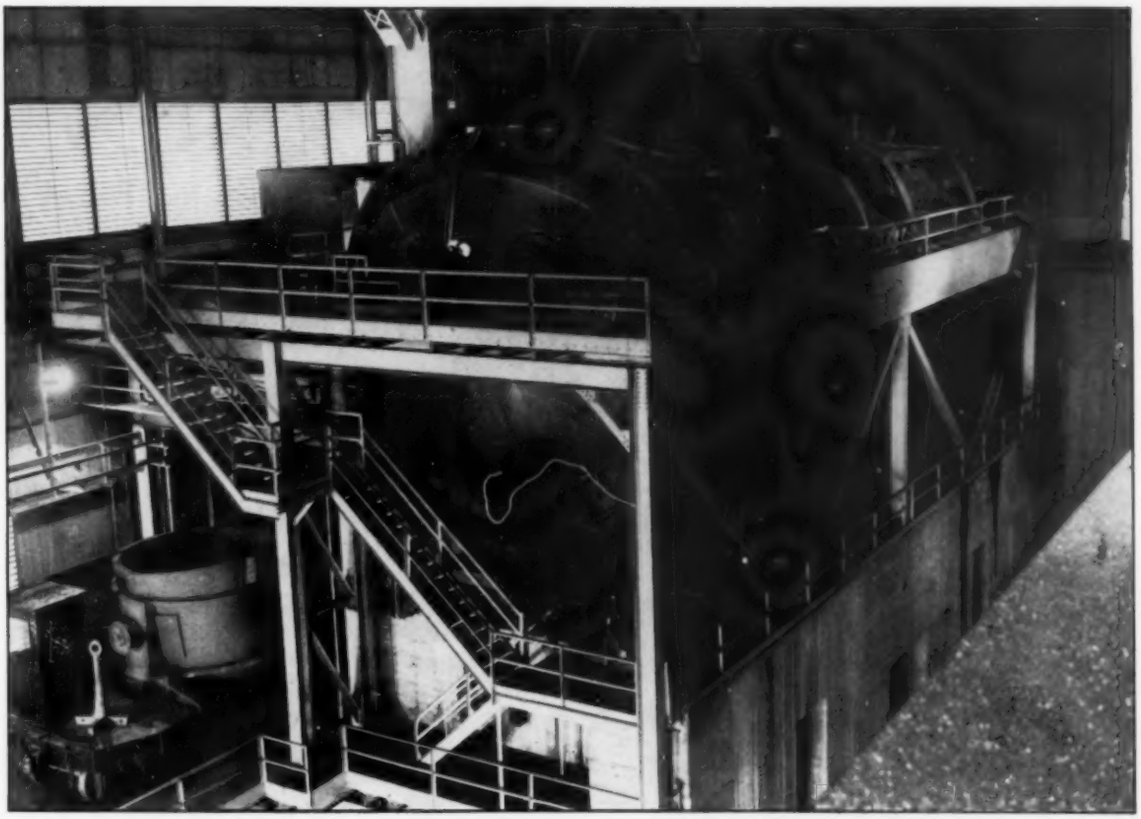

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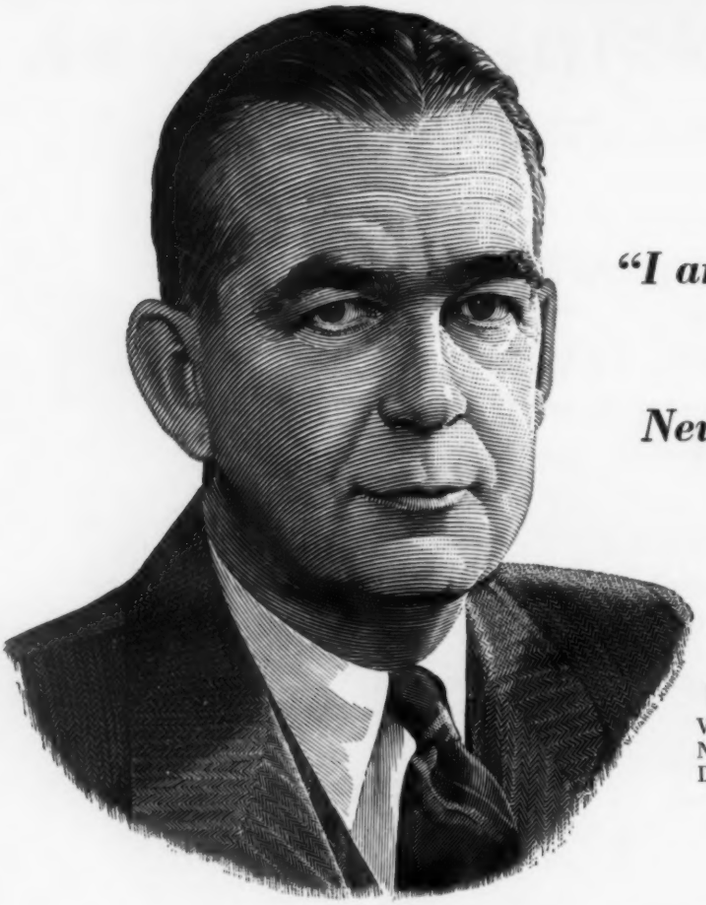

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(*Continued from page 242*)

ard item on all their "striking line" of hand tools.

A story was made to determine other causes of accidental injuries relative to the function of the tools

themselves. This analysis revealed that a good percentage of injuries were caused by "striking tools" such as hammers, sledges, etc., which often slip from the worker's hand and either inflict injury to himself or persons near his work.

After various tests and revisions were performed on newly designed handles, the final solution involved numerous conical impressions on the handle which caused a vacuum as the palm of the hand made a firm contact. Consequently, the slipping problem was minimized even with oily or greasy hands.

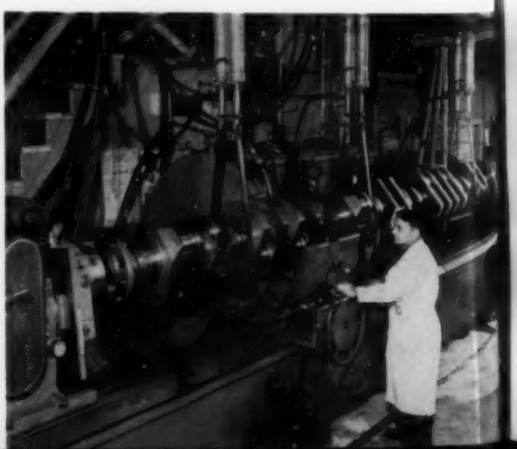
The vacuum grip has other features. It helps to prevent excessive perspiration and the forming of blisters on the hands. Tests show that this new type handle actually massages away many existing bothersome hand callouses. If a smooth handle is grasped firmly for a few seconds and the grasp released quickly, the palm of the hand is white, showing that the blood had been driven from the surface of the skin. The lapsed time of the whiteness is only a few seconds. However, when a vacuum grip handle is grasped as firmly and released as quickly, the places of the vacuum cups are revealed in the form of red dots. Hence, as the grasp shifts in working, blood is permitted to nourish the skin in the palm of the hand, keeping it alive, and thereby, preventing the formation of callouses.

PLATING PROCESS

▲ A new hard chrome plating and grinding process designed especially for worn, locomotive Diesel engine parts, which delivers finished work closer than new part tolerances, has been developed by Precision Engineering Co., Los Angeles, Calif.

Worn crankshaft, crankcases and other engine parts are first preground to produce a true contour throughout, then built up electrolytically with hard chrome plating. Crankshaft journals are pre-ground to exacting specifications on 45 ft "floating" precision equipment which delivers finished work within tolerances as close as .0001. A much harder surface than the original shaft is produced, and performance tests show more than one-half million miles of extra service with no measurable wear, according to company officials. It is reported that this new process is accomplished at a fraction of new part costs.

Worn parts are pre-ground on precision equipment such as this 45 ft unit, which produces a surface harder than the original.



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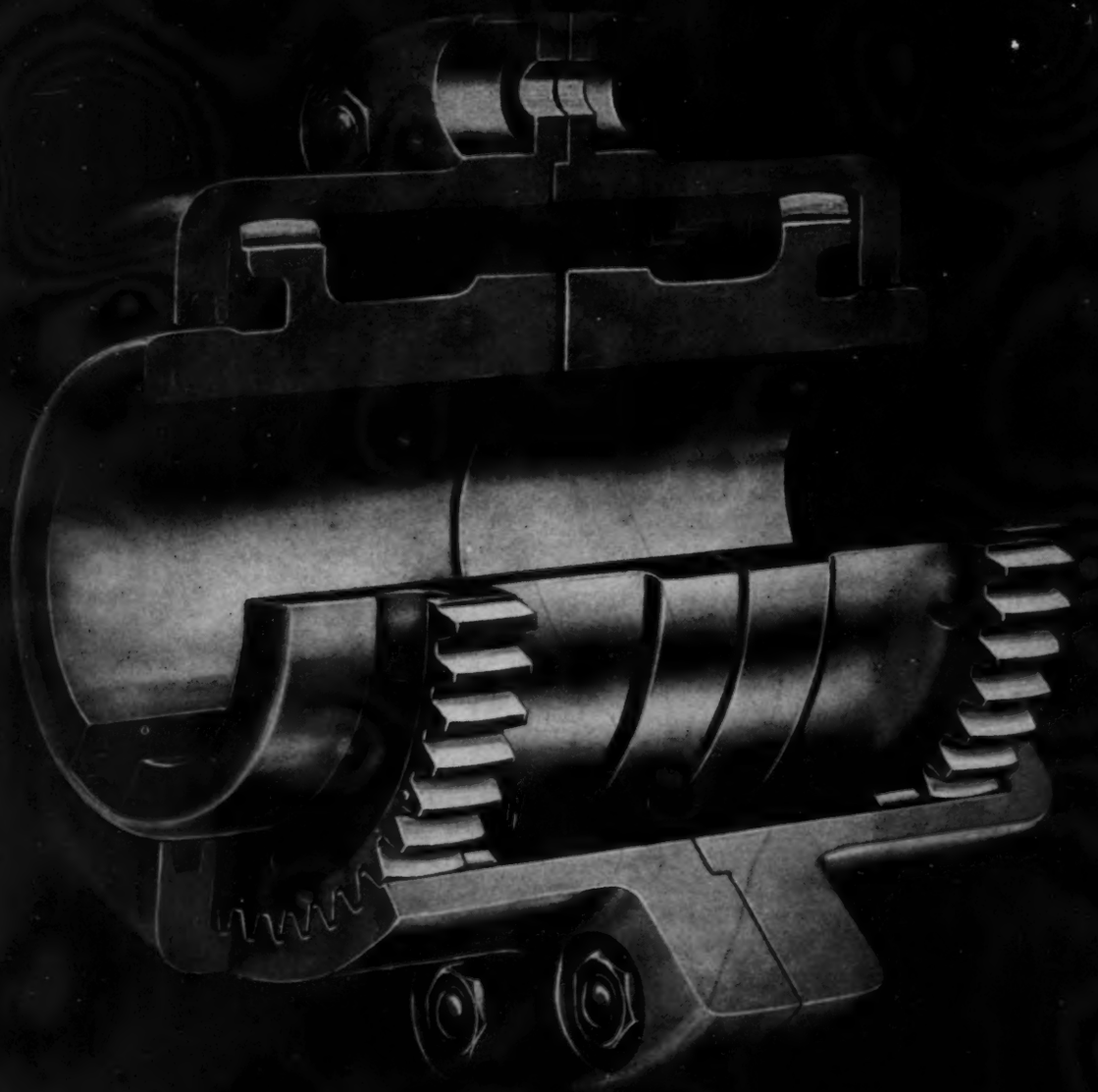

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WOODBERRY, BALTIMORE, MD.

Farval saves 50 minutes of each lubricating hour on Clearing press

FARVAL—*Studies in Centralized Lubrication*
No. 150

GOOD news for cost-conscious management! Lubrication studies show that Farval saves 50 minutes out of every hour of oiling labor.

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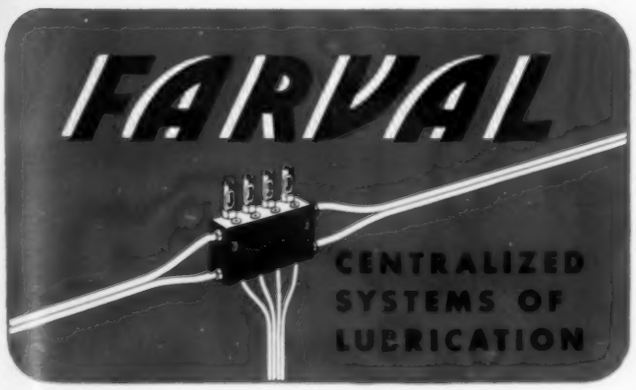

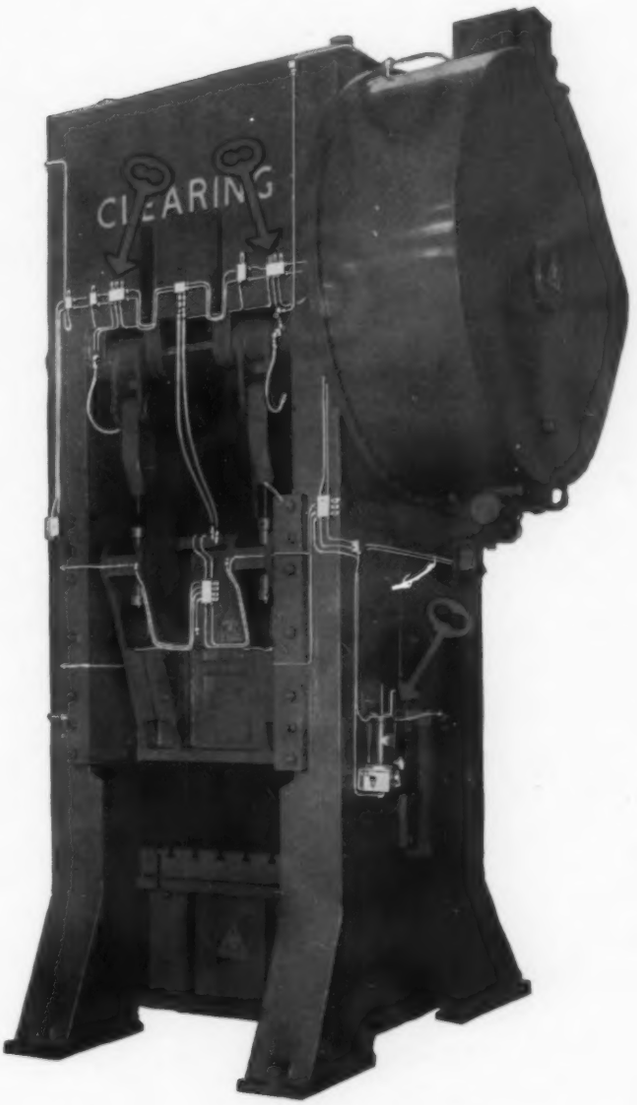

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